Dawson Creek Timber Supply Area Analysis Report

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Preface

This report contains a timber supply analysis and a socio–economic analysis and is part of the provincial Timber Supply Review (TSR) carried out by the British Columbia Forest Service. The purpose of the review is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvesting in timber supply areas (TSAs) and tree farm licences (TFLs) throughout British Columbia. To determine allowable timber harvesting levels, the chief forester must have an up-to-date assessment of the timber supply that is based on the best available information and reflects current management direction. **The report that follows provides this assessment but should not be considered as a recommendation on permissible harvest levels.**

This report focuses on a single forest management scenario — current management practices. Current management practices are defined by the specifications in management plans for the timber supply area including guidelines for the protection of forest resources, the *Forest Practices Code (FPC) of B.C. Act* and official land-use decisions made by Cabinet.

Focussing the assessment on the implications of current practices rather than looking at a number of different management regimes expedites the analysis process. An important part of these analyses is an assessment of how results might be affected by uncertainties — a process called sensitivity analysis. Together, the sensitivity analyses and the assessment of the effects of current forest management on the timber supply provide a basis for discussions among stakeholders about alternative timber harvesting levels.

In addition to having an up-to-date assessment of timber supply when setting the allowable annual cut (AAC) the chief forester considers short- and long-term implications of alternative harvest levels, capabilities and requirements of existing and proposed processing facilities, and the social and economic objectives of the Crown. The socio-economic analysis provides the chief forester with some of the information necessary for these considerations.

This report is the third of five documents that will be released for each TSA as part of the timber supply review. (The first two documents are the information report and the data package). A fourth document called the public discussion paper will summarize the technical information and will provide a focus for public discussions of possible timber harvest levels. The fifth will outline the chief forester's harvest level decision and the reasoning behind it.

Executive Summary

As part of the provincial Timber Supply Review, the British Columbia Forest Service has examined the availability of timber in the Dawson Creek Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over the short- (next 20 years), medium- (21 years to 100 years from the present) and long- (beyond 100 years from the present) terms. It also examines the potential changes in timber supply stemming from uncertainties about forest growth and management actions. **It is important to note that the various harvest forecasts included in the report indicate only the timber supply implications of current practices and uncertainty. As such, the forecasts should be used for discussion purposes only; they are not allowable annual cut (AAC) recommendations.**

The Dawson Creek Timber Supply Area (TSA) is situated in the northeastern interior of British Columbia and covers approximately 2.3 million hectares. The TSA is bounded to the north by the Peace River and to the east by the Alberta border. To the west are the Hart Ranges and to the south lie the Front Ranges which are characterized by the mountainous terrain and steep valleys of the Rocky Mountains.

About 60% of the TSA is considered productive forest land managed by the B.C. Forest Service. Currently about 52% of this forested land is considered available for timber harvesting under current forest management assumptions. The estimated current timber harvesting land base is 730 220 hectares of which 469 878 hectares are dominated by coniferous species and 260 342 hectares by deciduous species. Interior spruce, lodgepole pine, subalpine fir, aspen and balsam poplar are the dominant tree species within the TSA that are available for harvesting. Forest management practices in the TSA follow the *Forest Practices Code (FPC)* and are guided by the *Dawson Creek Land and Resource Management Plan (LRMP).*

The current AAC for the Dawson Creek TSA is approximately 1.733 million cubic metres per year, of which 846 533 are attributed to coniferous–leading stands and 886 500 cubic metres are from deciduous-leading stands.

Timber supply was assessed for the Dawson Creek TSA and specific harvest forecasts for coniferous-, deciduous- and small pine-leading stands were investigated in detail. The base case projection suggests that a total harvest level of 2 078 000 cubic metres per year could be maintained for up to five decades before declining to a steady long-term harvest level of 1 759 000 cubic metres per year.

In the analysis, small pine stands were defined as lodgepole pine stands older than 80 years, and between 17.5 and 19.4 metres tall. The base case suggests that it is possible to harvest 100 000 cubic metres per year of small pine for up to 19 decades before declining by 10% per decade to a long-term harvest level of 72 000 cubic metres per year.

The coniferous forecast includes the contribution from interior spruce- and subalpine fir-dominated stands as well as lodgepole pine stands that are, or have the potential to grow to at least 19.5 metres tall by age 80 years. Results suggest that the timber supply associated with coniferous stands can be maintained at 1 098 000 cubic metres per year over the entire forecast horizon.

For deciduous stands, the results of this analysis suggest that the current deciduous AAC of 880 000 cubic metres per year (adjusted to account for woodlots) can be maintained for up to five decades. Timber supply then declines by 10% per decade to a long-term harvest level of approximately 588 000 cubic metres per year in decade nine.

The timber supply analysis examined the impact of increasing the initial harvest levels for each harvest component by increments of 10% or more. The analysis suggests that the initial coniferous harvest level can be increased by 10% and maintained for up to three decades without disrupting long-term timber supply. Initial increases of 10% and 35% are possible for the deciduous and small pine harvest components, respectively, with no disruptions to long-term timber supply. The high proportion of merchantable growing stock relative to the current harvest level can provide significant flexibility and a buffer against uncertainties that affect timber supply.

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Inclusion of new vegetation resources inventory (VRI) information was a key feature of the timber supply analysis. Statistically-based height, age and volume adjustment factors for spruce-, pine-, subalpine fir- and deciduous–leading stands were applied to the forest cover inventory and incorporated into the associated yield projections. In the timber supply analysis a sensitivity analysis was performed to provide insight into the effects of the VRI adjustments on the timber harvesting land base and projected timber supply.

If the VRI adjustments had not been applied, the area of the timber harvesting land base would be about 6000 hectares smaller because fewer stands meet the minimum productivity criteria assumed in the base case. Without the VRI adjustments, the total short-term harvest level is approximately 10% lower than projected in the base case, while medium- and long-term timber supply are about 20% and 14% lower respectively than in the base case. Because the volume adjustment ratios are typically larger for deciduous-leading stands than for coniferous stands, application of the VRI has a proportionately greater impact on deciduous harvest levels than on the coniferous forecast.

Sensitivity analyses were performed to test the potential impact of uncertainties in inventory, growth and yield and current forest management assumptions. The analyses showed that uncertainties in harvest scheduling priority, the size of the timber harvesting land base, existing and regenerating stand yields estimates, and site productivity estimates have the largest impacts on the base case forecast.

A relative-oldest-first harvest rule was assumed in the base case. However, because of physical and economic considerations, harvesting the oldest stands first does not always reflect operational practice. Sensitivity analysis illustrated that applying a more random approach to harvesting has significant timber supply impacts throughout the forecast horizon. Overall timber supply was reduced by 10% in the short term and up to 21% in the long term compared to the base case projection.

Several sensitivity analyses were done to explore the impact on timber supply of uncertainty in the timber harvesting land base. Standard analyses were done to test the impact of increasing and decreasing the size of the timber harvesting land base by 10%. In addition, the potential impact of removing a proportion of areas identified as agricultural land reserve (ALR) was explored. The analysis showed that excluding 25% of the ALR area from the timber harvesting land base following harvest primarily impacts long-term timber supply, and in particular the deciduous component.

Short-term timber supply is sensitive to changes that influence the amount of timber available from existing unmanaged stands, because the base case harvest relies almost entirely on harvests from these stands for the next 80 years. Sensitivity analysis showed that if existing stand volumes were 10% lower than assumed in the base case, the maximum even-flow coniferous harvest would have to be reduced by only 3%, while the deciduous harvest level could still be maintained for up to 3 decades before declining. In the Dawson Creek TSA, uncertainty in existing stand volumes primarily affects medium-term timber supply, during the transition from existing to regenerating stands.

Uncertainty in regenerating stand volumes primarily affects medium- and long-term timber supply. If regenerating stand volumes were 10% higher than estimated in the base case, long-term timber supply would increase by about 8% compared to the base case forecast. By contrast, a reduction in regenerating stand volumes reduced total long-term timber supply by approximately 10%. In the case of reduced volumes, coniferous even-flow harvest level of 982 000 cubic metres per year (16% above the current AAC), could be achieved for the entire forecast horizon.

Approximately 14% of the timber harvesting land base comprises stands that are older than 140 years of age. Sensitivity analysis examined the uncertainty associated with site productivity estimates by applying provincial old-growth site index (OGSI) adjustments to stands older than 140 years. The timber supply analysis suggests that the base case harvest level may be underestimated by up to 7% in the long term on account of this factor.

Uncertainties and issues with small to negligible impacts on timber supply included: allowable denudation rates within visually sensitive areas; minimum harvestable age; reduced yields on areas used for livestock grazing (i.e., community pastures, grazing leases and permits), potential yield reductions in areas managed using strip shelterwood silvicultural systems; and, natural disturbance outside of the timber harvesting land base.

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An additional sensitivity analysis was performed to further review the timber supply implications of uncertainty in the existing volumes of small pine stands. The results showed that if volume estimates for existing stands were reduced by 45% the initial small pine harvest level projected in the base case (100 000 cubic metres per year) could still be maintained for 5 decades.

In preparing for the analysis it was acknowledged that mixed-wood stands comprise a large proportion of the productive forest within the Dawson Creek TSA. However, the timber supply analysis did not attempt to address the complex issues associated with the successional patterns of the boreal mixed-wood forest in the TSA. In the analysis it was assumed that these stands would continue to contribute to the coniferous or deciduous harvest depending on their current species composition. Given the extent of these stands in the TSA and the results of local study and investigation elsewhere in the province, the issue of complex stand dynamics and its impact on timber supply remains a significant source of uncertainty in the Dawson Creek TSA.

The analysis also included a socio-economic component. The public sector is the leading source of employment and income for local residents of the Dawson Creek TSA, followed by the forest sector, business- and tourism-related travel and the agriculture sector. Mining was a significant source of employment throughout the 1980s and 1990s. However, the recent closure of the Quintette coal mine and the expected 2003 closure of the Bullmoose coal mine, both in Tumbler Ridge, will significantly reduce mining's contribution to the region's economy.

From 1999 to 2001, the volume of timber harvested in the Dawson Creek TSA averaged approximately one million cubic metres per year. This harvest supported about 767 direct person-years of employment and a further 983 person-years of indirect and induced employment. Residents of the TSA account for about 53% of this total employment.

The current AAC of 1 733 033 cubic metres, if fully harvested and processed, can support about 1,230 person-years of direct forestry employment, and a further 1,577 person-years of indirect and induced employment across the province. The employment income associated with this direct, indirect and induced employment would be about $106.6 million per year.

Based on the average 1999-2001 harvest, the provincial government currently collects about $32.7 million per year in stumpage and related payments, other industry taxes and provincial income taxes. Increasing harvest and processing activities to utilize the entire current AAC would result in government revenues of about $52.5 million per year.

Increasing the timber supply to the level projected in the base case, 2 078 000 cubic metres per year, would provide additional opportunities; however, it is uncertain if demand and processing capacity would increase to utilize this additional volume. Nevertheless, the stable timber supply indicated by the timber supply forecast is capable of supporting current or increased employment and income levels assuming market accessibility and demand.

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Introduction

Timber supply* is the quantity of timber available for harvest over time. Timber supply is dynamic, not only because trees naturally grow and die, but also because conditions that affect tree growth, and the social and economic factors that affect the availability of trees for harvest, change through time.

Assessing the timber supply involves considering physical, biological, social and economic factors for all forest resource values, not just for timber. Physical factors include the land features of the area under study as well as the physical characteristics of living organisms, especially trees. Biological factors include the growth and development of living organisms. Economic factors include the financial profitability of conducting forest operations, and the broader community and social aspects of managing the forest resource.

All of these factors are linked: the financial profitability of harvest operations depends upon the terrain, as well as on the physical characteristics of the trees to be harvested. Determining the physical characteristics of trees in the future requires knowledge of their growth. Decisions about whether a stand is available for harvest often depend on how its harvest could affect other forest values, such as wildlife or a recreation area.

These factors are also subject to both uncertainty and different points of view. Financial profitability may change as world timber markets change. Unforeseen losses due to fire or pest infestations will alter the amount and value of timber. The appropriate balance of timber and non-timber values in a forest is an ongoing subject of debate, and is complicated by changes in social objectives over time.

Thus, before an estimate of timber supply is interpreted, the set of physical, biological and socio-economic conditions on which it is based, and which define current forest management — as well as the uncertainties affecting these conditions — must first be understood. Timber supply analysis is the process of assessing and predicting the current and future timber supply for a management unit (a geographic area). For a timber supply area (TSA)*, the timber supply analysis forms part of the information used by the chief forester of British Columbia in determining an allowable annual cut (AAC)* — the permissible harvest level for the area.

Timber supply projections made for TSAs look far into the future — 250 years or more. However, because of the uncertainty surrounding the information and because forest management objectives change through time, these projections should not be viewed as static prescriptions that remain in place for that length of time. They remain relevant only as long as the information upon which they are based remains relevant. Thus, it is important that re-analysis occurs regularly, using new information and knowledge to update the timber supply picture. This allows close monitoring of the timber supply and of the implications for the AAC stemming from changes in management practices and objectives.

**Throughout this document, an asterisk after a word or phrase indicates that it is defined in a box at the foot of the page, as well as in the glossary.*

Timber supply
The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)
An integrated resource management unit established in accordance with Section 7 of the Forest Act.

Allowable annual cut (AAC)
The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.

Introduction

Timber supply analysis involves three main steps. The first step is collecting and preparing data and information. The B.C. Forest Service forest inventory* plays a major role in this step. The second step is using the data along with a timber supply computer model or models* to make projections or estimates of possible harvest levels over time. These projections are made using different sets of assumed values or conditions for the factors discussed above. The third step is interpreting and reporting results.

The following sections outline the timber supply analysis for the Dawson Creek TSA. Following a brief description of the area in Section 1, data preparation and formulation of assumptions are discussed in Section 2. Timber supply analysis methodology and results are presented in Sections 3 and 4. Section 5 examines the sensitivity of the results to uncertainties in the data and assumptions used. This is followed by summary and conclusions for the timber supply analysis in Section 6. Section 7 shows results of a socio-economic analysis for the Dawson Creek TSA. Appendixes A and B contain further details about the data and assumptions used in the analysis.

As part of the timber supply review (TSR), information is gathered on the short- and long-term implications of alternative harvest levels, and the capabilities and requirements of existing and proposed processing facilities. The socio-economic analysis provides information for the chief forester and the local community to better understand the potential magnitude of impacts associated with any proposed harvest level changes.

Forest inventory
An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.

Model
An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.

1 Description of the Dawson Creek Timber Supply Area

The Dawson Creek timber supply area (TSA) is situated in the northeastern interior of British Columbia and covers approximately 2.3 million hectares. This TSA is one of six TSAs in the Prince George Forest Region and is administered from the Dawson Creek Forest District office, located in Dawson Creek. The forest district boundary includes a larger area that includes Tree Farm Licence (TFL)* 48.

The Dawson Creek TSA is bounded to the north by the Peace River and to the east by the Alberta border. To the west are the Hart Ranges and to the far south lie the Front Ranges, which are characterized by the mountainous terrain and steep valleys of the Rocky Mountains. The TSA also encompasses the rolling terrain of the Peace and Hart Foothills, and the relatively flat Kiskatinaw Plateau. Major tributaries of the Peace River that flow through the TSA include the Pine, Moberly, Sukunka, Murray and Kiskatinaw rivers.

In 2001, the population of the Dawson Creek TSA was estimated to be 26,449, a decline of about 10% since 1996. The main population centre is Dawson Creek, where about 40% of the TSA population live. Other communities include Tumbler Ridge, Chetwynd, Hudson's Hope and Pouce Coupe. Two First Nations communities in the TSA include the West Moberly and Saulteau, as well, there is a Metis community at Kelly Lake.

In March 1999, the provincial government approved the Dawson Creek Land and Resource Management Plan (LRMP)*. The objectives of this strategic land-use plan are to guide resource management activities, reduce land and resource use conflicts, and provide economic security for resource development. The plan includes recommendations regarding new protected areas* and parks, all of which are now formally designated, with the exception of the Peace River – Boudreau Lake protected area which is expected to be managed as a protected area under the *Environment and Land Use Act*. Currently, no higher level plans* have been established for the TSA. The timber supply analysis reflects only land-use and forest management decisions that have final approval from government.

The forests of the Dawson Creek TSA provide a wide range of natural resources, including forest products, forage, minerals, recreation and tourism amenities, oil and gas reserves, and fish and wildlife habitats. Parks, recreation sites and trails, and roaded and non-roaded areas provide opportunities for numerous outdoor activities including mountain-biking, all-terrain-vehicle use, horseback riding, hiking, spelunking, hunting, camping, boating, cross-country skiing and snowmobiling. Parks within the TSA include Monkman, Gwillim and Kakwa provincial parks. Recreation areas include Kinuseo Falls, Moberly Lake, Stewart Lake, Wapiti-Onion Lake, One Island Lake and Williston Lake.

About 60% of the TSA land base is considered productive forest land managed by the B.C. Forest Service (approximately 1.4 million hectares). Currently about 52% of this forested land base is considered available for harvesting (31% of the total TSA land base).

Within the land base currently considered available for timber harvesting, spruce (Engelmann, white and hybrid), lodgepole pine, trembling aspen and balsam poplar dominate coniferous* and deciduous* timber types.

Tree farm licence (TFL)
Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.

Land and Resource Management Plan (LRMP)
A strategic, multi-agency, integrated resource plan at the subregional level. It is based on the principles of enhanced public involvement, consideration of all resource values, consensus-based decision making, and resource sustainability.

Protected area
A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).

Higher level plans
Higher level plans establish the broader, strategic context for operational plans, providing objectives that determine the mix of forest resources to be managed in a given area.

Coniferous
Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.

Deciduous
Deciduous trees shed their leaves annually and commonly have broad-leaves.

1 Description of the Dawson Creek Timber Supply Area

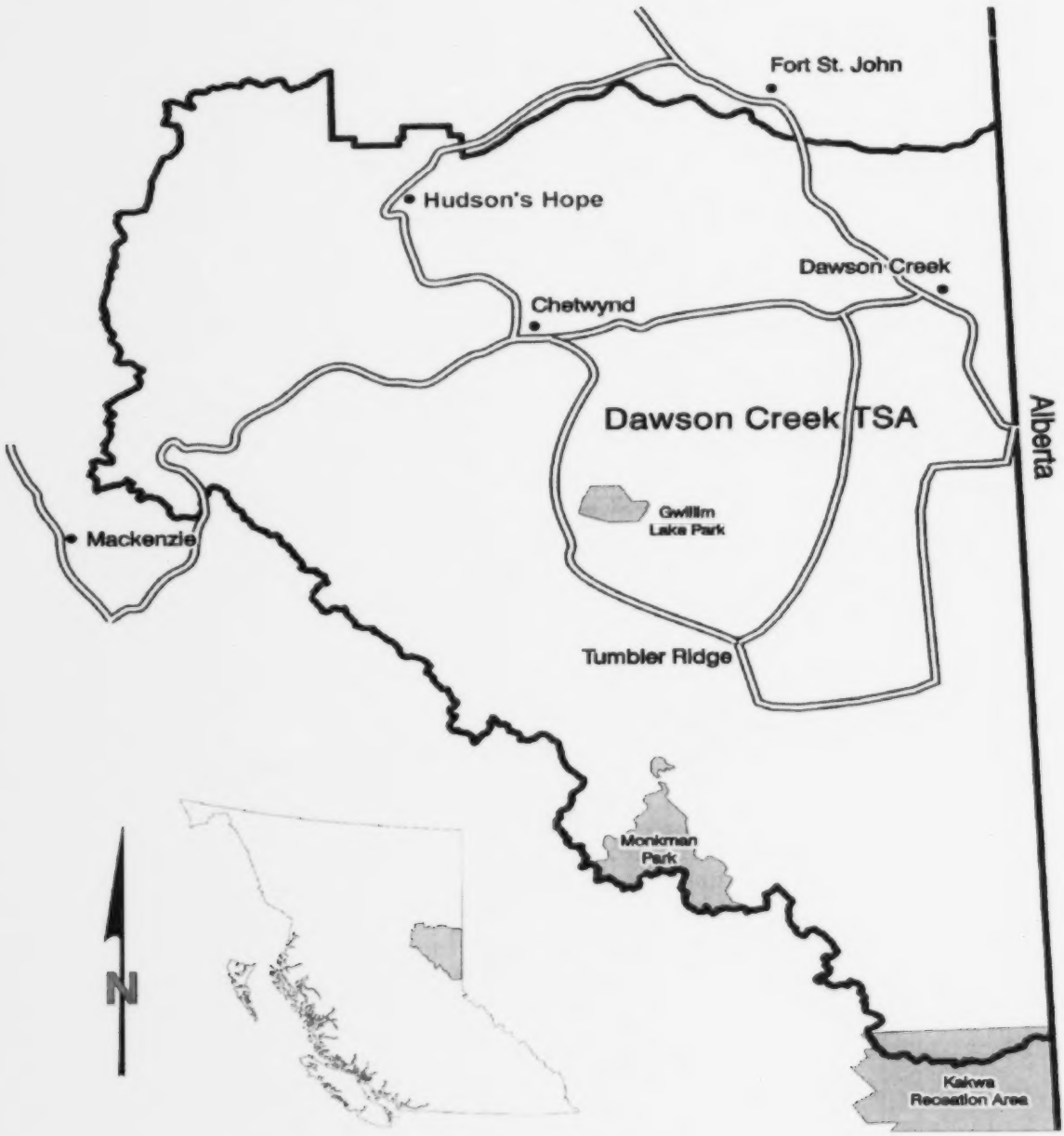


Figure 1. Map of the Dawson Creek Timber Supply Area, Prince George Forest Region.

1 Description of the Dawson Creek Timber Supply Area

The current allowable annual cut (AAC) for the Dawson Creek TSA is 1.733 million cubic metres. This level was set by the chief forester, effective December 30, 1996 and represented a decrease of approximately 6% from the previous AAC. The current AAC is attributed as follows:

- 846 533 cubic metres to coniferous-leading stands, of which at least 100 000 cubic metres must be from small-diameter pine stands; and
- 886 500 cubic metres to deciduous-leading stands.

Significant changes that influence forest management have occurred since the last timber supply review was completed. These changes include:

- implementation of the *Forest Practices Code** *Act* and regulations;
- approval of the Dawson Creek Land and Resource Management Plan, and designation of protected areas and parks;
- updating of forest inventory data using Vegetation Resources Inventory (VRI) methodology;
- development of an estimate of unsalvaged losses* for deciduous stands (through VRI phase II sampling);
- development of a management strategy for boreal mixed-wood* stands (in progress);
- development of a pesticide management plan that the Ministry of Water, Land and Air Protection is implementing;
- visual quality objectives (VQO)* have been established and scenic areas* made known;
- definition of environmentally sensitive areas (ESA)*, ungulate* winter range and ungulate habitat burn areas (in progress);
- development of management strategies for low elevation caribou habitat (in progress); and
- identification of wildlife habitat areas (WHA) for bull trout and mountain goats (some have been established).

Forest Practices Code
Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.
Unsalvaged losses
The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) that is not harvested.
Mixed-wood
Forests that have a mix of coniferous and deciduous trees.
Visual quality objective (VQO)
Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.

Scenic area
Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.
Environmentally sensitive areas
Areas with significant non-timber values, fragile or unstable soils, impediments to establishing a new tree crop, or high risk of avalanches.
Ungulate
A hoofed herbivore, such as deer.

1 Description of the Dawson Creek Timber Supply Area

1.1 The environment

The four biogeoclimatic zones* that are represented in the Dawson Creek TSA reflect the diversity of climates and vegetation in the area. The distinct ecological features and unique nature of the area contribute to the biodiversity* values found in this TSA.

The Boreal White and Black Spruce (BWBS) zone occurs on the plateau area in the eastern portion of the TSA, and occupies the majority of the area of the TSA. This zone is characterized by a severe climate with long, very cold winters and a short growing season. White spruce, trembling aspen, lodgepole pine, black spruce, balsam poplar, larch, subalpine fir, and paper birch are the major tree species found in the forests of this zone. Forest fires are frequent throughout the zone, maintaining most of the forests in various successional stages.

The Sub-Boreal Spruce (SBS) zone occurs at lower to mid-elevations in the western part of the TSA. This zone is characterized by seasonal extremes of temperature, with severe, snowy winters and relatively warm, moist and short summers. Hybrid spruce, subalpine fir, lodgepole pine, paper birch and trembling aspen are the most common tree species.

In the Dawson Creek TSA, the Engelmann Spruce-Subalpine Fir (ESSF) zone occurs at elevations above the SBS zone in the western part of the TSA. The ESSF zone has a continental climate, with cool, moist and short growing seasons, and long, cold winters. The ESSF zone is comprised of continuous forest at its lower elevations and parkland at its higher elevations. Subalpine fir is the dominant tree species throughout the zone; hybrid spruce and lodgepole pine are common in drier parts of the zone that have been influenced by fire.

The Alpine Tundra (AT) zone occurs at high elevations above the ESSF zone in the western and southern parts of the TSA. The climate of the AT zone is cold, windy and snowy with a short, cool growing season. Frost can occur at any time during the year. This zone is mostly treeless, although trees in stunted form are common at lower elevations. Vegetation is dominated by shrubs, herbs, mosses and lichens. Much of the alpine landscape lacks vegetation and is the domain of rock, ice and snow.

Biogeoclimatic zones
A large geographic area with broadly homogeneous climate and similar dominant tree species.

Biodiversity (biological diversity)
The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.

1 Description of the Dawson Creek Timber Supply Area

The forests of the Dawson Creek TSA support many species of wildlife, including large mammals such as moose, elk, deer, caribou, mountain goat, bighorn sheep, Stone sheep and grizzly bears, and at least 23 species of non-game mammals including fishers, bats, shrews, rabbits, hares and rodents. The rivers of the TSA support many fish species, including bull trout, Arctic grayling, mountain whitefish, rainbow trout, pike, walleye and salmon species. Only a few lakes in the TSA contain native fish species; most contain stocked fish. Waterfowl are particularly dependent on the numerous wetland areas in the TSA; 26 species of ducks, three species of geese and two species of swan are found, along with a variety of other bird species.

Under the *Forest Practices Code of British Columbia Act*, a process exists for identifying species at risk and designating wildlife habitat areas with specific management practices. The wildlife species that have been identified in Volume 1 of the provincial *Identified Wildlife Management Strategy* in the six ecosections of the Dawson Creek Forest District are presented in Table 1.

Table 1. Species at risk under the Forest Practices Code (February 1999)

Common names of identified wildlife	Ecosection					
	Hart Foothills	Hart Ranges	Peace Foothills	Front Ranges	Kiskatinaw Plateau	Peace Lowland
Bull trout	X	X	X	X	X	X
Trumpeter swan			X		X	X
Northern goshawk *atricapillus*	X	X	X	X	X	X
Fisher	X	X	X	X	X	X
Grizzly bear	X	X	X	X	X	X
Mountain goat	X	X	X	X	X	
Bighorn sheep *canadensis*		X		X		

Source: Managing Identified Wildlife, Volume 1, February 1999.

1 Description of the Dawson Creek Timber Supply Area

Current forest management practices follow the legislation and guidelines set out by the *Forest Practices Code of British Columbia Act* and regulations. Consequently, the protection of wildlife and the environment is managed through the *Code*. In addition, the Dawson Creek LRMP provides further management direction for public forest lands in the Dawson Creek TSA, as well as for wildlife species not included in the above list.

1.2 First Nations

The Dawson Creek TSA lies completely within the area outlined as Treaty 8 Territory. Both the West Moberly and the Saulteau First Nations are signatories of Treaty 8 and have reserves and traditional territories within the TSA, with a total population of over 900 residents. The Halfway River First Nation and McLeod Lake Indian Band are also signatories of Treaty 8 and have traditional land-use interests within the TSA, but their reserves and traditional territories are outside the TSA. In addition, the Lheidli T'enneh Band (which is not part of Treaty 8) has traditional land-use interests within the TSA, and its reserve is also located outside the TSA. A significant number of Metis and other aboriginal people reside within the TSA, notably in the Kelly Lake community.

A number of First Nations people are employed with local forest companies, and some bands have direct involvement in the forest industry, through silviculture contracts, small forest licences or joint ventures with non-aboriginal companies. Trapping, hunting and fishing are traditional activities that are important to the economic and social structure of First Nation communities in the area. The Treaty 8 First Nations have expressed concern about the impacts of logging activities on trapping, moose populations and other resource values.

The Dawson Creek TSA contains numerous known sites and areas of cultural significance for First Nations. An archaeological overview assessment (AOA), which identifies sites of potential cultural and heritage significance, has been developed for the TSA. As archaeological impact assessments and traditional-use surveys are completed, they are considered in operational planning. Known information regarding cultural or archaeological sites has been considered in the timber supply review.

2 Information Preparation for the Timber Supply Analysis

Timber supply analysis requires three general categories of information: land base inventory; timber growth and yield data; and management practices. These three categories are discussed below. In preparation for the analysis, a number of changes since the 1994 Dawson Creek TSA timber supply analysis were noted, as described in Section 1, "Description of the Dawson Creek TSA."

2.1 Land base inventory

Land base information used in this analysis was compiled in 2001 by the B.C. Forest Service. This file contains information on the forest land in the Dawson Creek TSA including general geographic location, area, forest cover (such as presence or absence of trees, species, number of trees, age, and timber volume), and other characteristics such as economic and physical accessibility (operability*). Stand attributes such as tree height, stocking* and age have been projected to 2000. The inventory file has been updated to account for timber harvesting using Forest Development Plan (FDP) information and is current to the end of 1999. Details of the inventory information used in the analysis are listed in Table A-1. of Appendix A.

The inventory file represents the land base for the entire TSA. It includes information on land that does not contain forest, and other areas where timber harvesting is not expected to occur. Examples are land set aside for parks, areas needed to protect wildlife habitat, areas in utility and transportation corridors, and residential and industrial development. A description of these areas specific to the Dawson Creek TSA is provided below. These types of areas do not contribute to the timber harvesting land base* of the Dawson Creek TSA. Before assessing timber supply, these non-contributing areas are identified as separate from the timber harvesting land base.

The B.C. Forest Service manages the entire area of the TSA (except for designated areas under the jurisdiction of other agencies) as a land unit that contributes a mix of timber and non-timber values. The timber supply is managed within this integrated resource context, and the analysis described herein is consistent with this philosophy.

Use of the term timber harvesting land base in this report does not mean the area is open to unrestricted logging. Rather, it implies that forests in the area contain timber of sufficient economic value, and sites of adequate environmental resilience, to accommodate timber harvesting with due care for other resources.

Operability
Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.

Stocking
The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.

Timber harvesting land base
Crown forest land within the timber supply area where timber harvesting is considered both acceptable and economically feasible, given objectives for all relevant forest values, existing timber quality, market values and applicable technology.

2 Information Preparation for the Timber Supply Analysis

The following describes the types of land that do not contribute to the timber harvesting land base.

- non-forest areas — areas not occupied by productive forest cover (e.g., rock, swamp, alpine areas and water bodies).
- woodlots — Crown managed productive forest excludes woodlots, which are not administered as part of the TSA for AAC determination.
- land not managed by the B.C. Forest Service — non-Crown areas such as private land, Indian reserves, federal and municipal lands.
- parks and eco-reserves — areas not administered by the B.C. Forest Service, but explicitly identified since they contribute to landscape-level biodiversity* objectives.
- non-commercial areas — areas occupied by non-commercial brush species.
- lake and riparian area* — areas unavailable for harvesting to provide protection for riparian habitat, stream ecosystems, and lakeshores.
- utility and transportation corridors — areas of forest land that have been removed from timber production due to road access and utility-related development.
- physically inoperable areas* — forested areas that are considered inoperable based on slope, and surficial geology information.
- problem forest types* (PFT) — stands which are physically operable and exceed low site criteria yet are not currently utilized or have marginal merchantability, such as leading-black spruce stands.
- economically inoperable — geographically-identified areas with projected high operating costs.
- high value recreation areas.
- non-merchantable forest types* — conventionally accessible stands that generally have less than 120 cubic metres per hectare at maturity, or cable or aerial accessible stands that have less than 200 cubic metres per hectare at maturity, are excluded.
- immature stands on low sites — areas occupied by younger forests with low timber growing potential.

Landscape-level biodiversity
The Landscape Unit Planning Guide provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.
Riparian area
Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.

Inoperable areas
Areas defined as unavailable for harvest for terrain-related or economic reasons. Operability can change over time as a function of changing harvesting technology and economics.
Forest type
The classification or label given to a forest stand, usually based on its tree species composition. Pure spruce stands and spruce-balsam mixed stands are two examples.
Non-merchantable forest types
Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.

- sensitive wildlife areas — areas critical for wildlife.
- wildlife tree* patches (WTP) — areas retained to maintain mature stand structure over time for biodiversity objectives.
- non-commercial deciduous species — deciduous stands currently not restocked and considered backlog not satisfactorily restocked (NSR)*.
- future roads, trails and landings — estimated forest land required to be removed from timber production due to future access development and harvesting.

A more detailed description of these categories, including specific criteria for exclusion is located in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Table 2 summarizes the areas in each category, and shows the area of the timber harvesting land base. The column "Crown forest area by classification" provides the total forested area managed by the B.C. Forest Service within the given category. For example, while there is a total of 69 035 hectares of forested land classified as riparian buffers, only 65 318 hectares were excluded specifically due to riparian protection because of the order in which exclusions were applied (e.g., areas previously excluded as non-commercial brush may have overlapped with riparian buffer, thus reducing the area explicitly excluded due to riparian buffers).

Wildlife tree
A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

Not satisfactorily restocked (NSR) areas
An area not covered by a sufficient number of well-spaced trees of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.

2 Information Preparation for the Timber Supply Analysis

Table 2. Determination of the timber harvesting land base for the Dawson Creek TSA, 2002

Classification	Crown forest area by classification (hectares)	Area (hectares)	Per cent (%) of TSA area	Per cent (%) of productive forest area
Total area on file		2 989 835		
Area within Tree Farm Licence (TFL) 48		644 724[a]		
Total TSA		2 345 111	100.0	
Non-forest land		664 153	28.3	
Woodlots		14 695	0.6	
Not managed by the B.C. Forest Service		157 121	6.7	
Parks and eco-reserves[b]		110 387	4.7	
Total forested area managed by the B.C. Forest Service (Crown forest)		1 398 755	59.6	100.0
Reductions to Crown forest				
Non-commercial brush	62 003	61 937	2.6	4.4
Riparian areas	69 035	65 318	2.8	4.6
Utility corridors	8 181	7 518	0.3	0.5
Transportation features	4 100	3 742	0.2	0.3
Physically inaccessible areas	44	34	0.0	0.0
Problem forest types	173 714	166 735	7.1	11.9
Economically inoperable	30 906	26 279	1.1	1.9
High value recreation	29 284	21 905	0.9	1.6
Non-merchantable stands	262 291	163 607	7.0	11.7
Low productivity — immature stands	130 602	89 789	3.8	6.4
Sensitive wildlife habitat	41 344	24 750	1.1	1.8
Wildlife tree patches (WTP)	39 135	22 288	1.0	1.6
Non-commercial deciduous		14 633	0.6	1.0
Total current reductions		668 535	28.5	47.8
Current timber harvesting land base (including NSR) Coniferous stands (including small pine) — 469 878 hectares Deciduous stands — 260 342 hectares		730 220	31.1	52.2
Future reductions — roads		34 005	1.5	2.4
Future timber harvesting land base		696 215	29.7	49.8

(a) Includes 5675 hectare Rice Properties.

(b) Parks and reserve forested land base is included in the analysis and contributes to landscape-level biodiversity objectives.

2 Information Preparation for the Timber Supply Analysis

Table 2 shows that of the total Dawson Creek TSA, about 60% is productive forested land base. After reductions for physical, environmental, social and economic values 52% of the productive forest or 31% of the TSA is available for timber harvesting activities. The major changes in the land base from the previous (1994) analysis are discussed below.

- Total TSA area — the total area is about 67 000 hectares larger than the previous analysis. This difference in area is attributed to inventory updates and changes to the Dawson Creek TSA boundary.
- Crown forest (productive forest land base) — the productive forest land base is 80 084 hectares smaller than the previous analysis. The difference in area is attributed to the creation of new parks and woodlots which have been excluded from the productive forest.
- Current timber harvesting land base — the timber harvesting land base is 81 442 hectares (approximately 10%) smaller than the previous analysis. The main reasons for the change in the land base since the last analysis are: new forest inventory classifications; excluded parks and eco-reserves, as well as area excluded for sensitive wildlife habitat and wildlife tree patches.

2 Information Preparation for the Timber Supply Analysis

Figure 2 and Table 3 show the distribution of the biogeoclimatic (BEC) variants in the Crown forested area. The last column of Table 3 shows the proportion of each BEC variant that is not available for harvest. For example, BWBSmw1 variant makes up 50.6% of the timber harvesting land base, while 54.5% of the total area of ESSFmv4 is outside of the timber harvesting land base. These percentages suggest that the forest outside the timber harvesting land base will meet most of the old-seral requirements if it is well-distributed among the landscape units (LU)*.

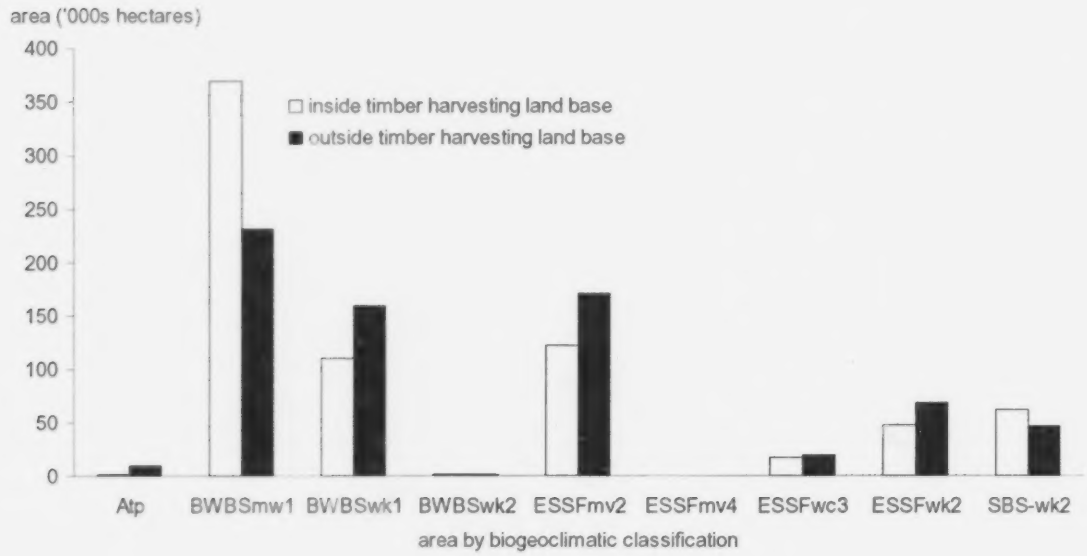


Figure 2. Biogeoclimatic variants in the Crown forested area — Dawson Creek TSA, 2002.

Landscape unit
A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

Table 3. Summary of biogeoclimatic zone areas — Dawson Creek TSA, 2002

Biogeoclimatic ecosystem classification (BEC) zone/variant	Per cent (%) of total forested area in BEC variant	Per cent (%) of timber harvesting land base in BEC variant	Per cent (%) of BEC variant outside the timber harvesting land base
AT	0.6	0.1	90.3
BWBSmw1	41.8	50.6	38.5
BWBSwk1	18.8	15.1	59.2
BWBSwk2	0.2	0.2	34.3
ESSFmv2	20.4	16.7	58.3
ESSFmv4	0.1	0.1	54.5
ESSFwc3	2.5	2.3	54.0
ESSFwk2	8.1	6.5	59.1
SBS-wk2	7.5	8.4	43.1
Total	100.0	100.0	Not applicable

2 Information Preparation for the Timber Supply Analysis

Table 4 shows the current composition of the timber harvesting land base by dominant tree species. Stands dominated by white spruce occupy the most area (34%), followed by aspen (29%) and then lodgepole pine (25%). After harvest, spruce- and pine-dominated stands are generally regenerated to a similar mixture of spruce and pine. Aspen sites regenerate naturally to aspen and may include supplemental planting of spruce or pine.

Table 4. Composition of the timber harvesting land base by leading tree species — Dawson Creek, TSA, 2002

Leading species	Area (hectares)	Per cent (%)
White spruce	248 230	34
Lodgepole pine	182 220	25
Subalpine fir (Balsam)	42 640	6
Aspen	215 232	29
Balsam poplar	41 778	6
Total	730 220	100

Analysis units (AU)* were derived by aggregating stands with similar species composition, site productivity and maturity classes (young, thrifty and old). The number of analysis units depends on the amount and distribution of stands with similar characteristics (see Appendix A, Section A.2.2, Analysis unit characteristics"). The following figures show generalized groupings by species composition, maturity and site index* ranges. Maturity is defined in relation to minimum harvestable age*.

Analysis unit
A grouping of types of forest — for example, by species, site productivity, silvicultural treatment, age, and or location — done to simplify analysis and generation of timber yield tables.

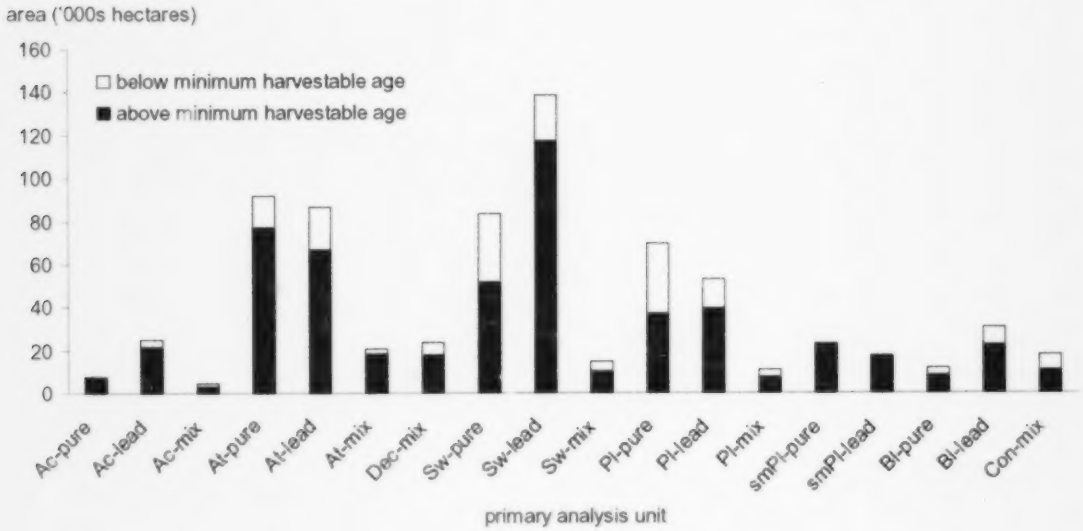
Site index
A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.

Minimum harvestable age
The age at which a stand of trees is expected to achieve a merchantable condition. The minimum harvestable age could be defined based on maximize average productivity (culmination of mean annual increment), minimum stand volume, or product objectives (usually related to average tree diameter).

2 Information Preparation for the Timber Supply Analysis

Figure 3 shows the composition of the timber harvesting land base by primary analysis unit and maturity class. Detailed analysis unit descriptions are contained in Table A-4.of Appendix A.

Currently 24% of the timber harvesting land base is covered by stands less than minimum harvestable age (MHA) and 76% is covered by stands greater than MHA.



Ac=balsam poplar	Pl=lodgepole pine
At=aspen	smPl=small pine
Dec=other decidous	Bl=subalpine fir
Sw=white spruce	Con=other conifferous

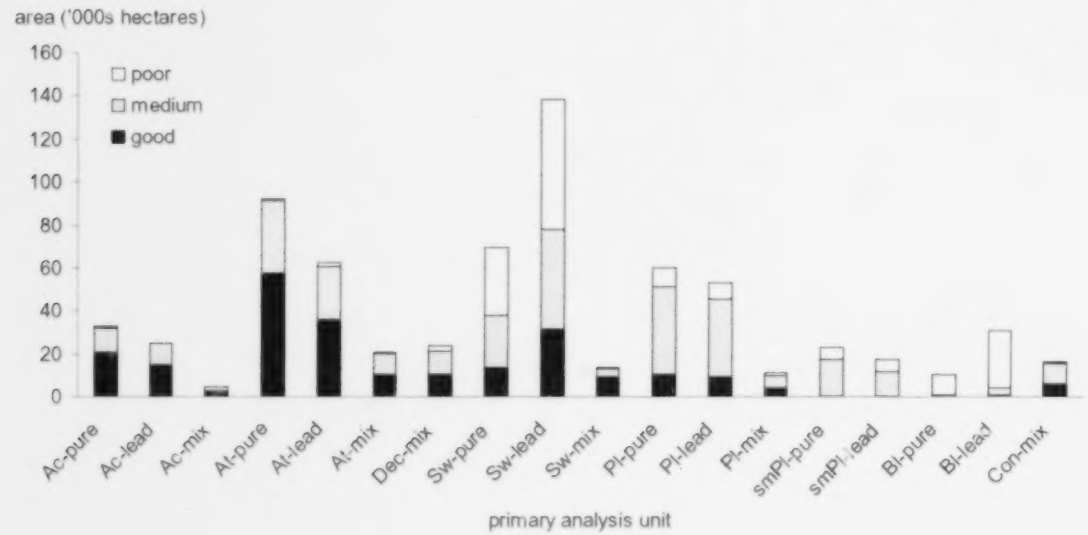
Figure 3. Timber harvesting land base by analysis unit and maturity — Dawson Creek TSA, 2002.

2 Information Preparation for the Timber Supply Analysis

Figure 4 shows the timber harvesting land base by generalized analysis unit and site index strata. Stands classified as poor comprise 23% of the land base, medium stands 45% and good stands 32%. On average, spruce stands occupy the poorer sites and aspen stands occupy the more productive sites. Definition of the site quality strata are included in Section A.2.2 of Appendix A.

Unless there was a history of harvesting, young stands of very low productivity were excluded from the timber harvesting land base. Older stands meeting the minimum volume criterion (120 cubic metres per year) were considered available for harvest.

Based on growth potential, existing stands not meeting 120 cubic metres per hectare by a given reference age (120 years for spruce and balsam, 100 years for pine, 80 years for deciduous) were excluded from the timber harvesting land base.



Ac=balsam poplar
At=aspen
Dec=other decidous
Sw=white spruce
Pl=lodgepole pine
smPl=small pine
Bl=subalpine fir
Con=other coniferous

Figure 4. Timber harvesting land base by timber growing potential — Dawson Creek, 2002.

2 Information Preparation for the Timber Supply Analysis

Figure 5 shows the current age class composition of the forested land. Less than 1% of the timber harvesting land base is occupied by stands older than 250 years. About 8% is covered with stands 20 years or younger, 49% with stands between 21 and 100 years old, and 43% with stands between 101 and 250 years old.

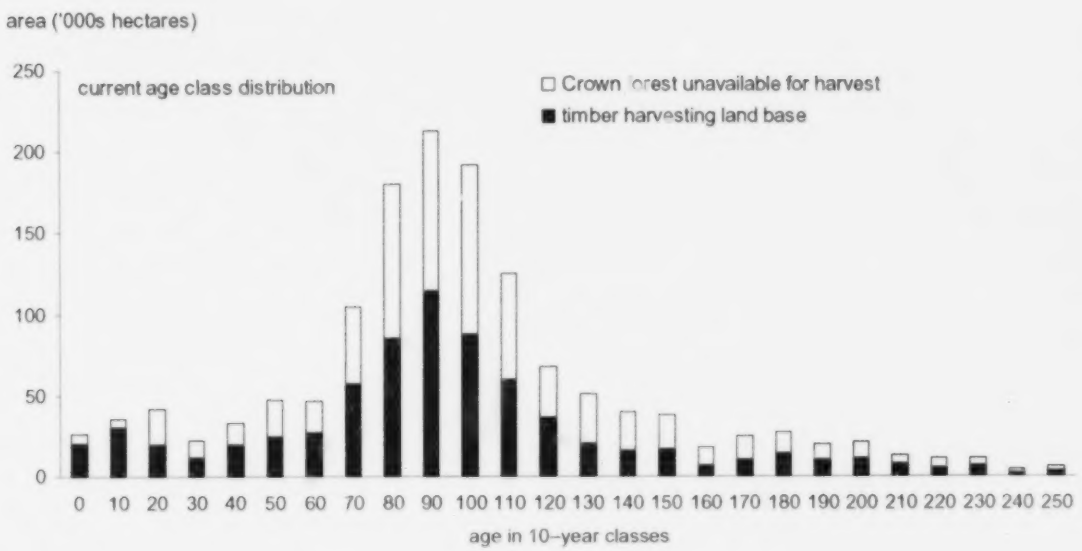

area ('000s hectares)
current age class distribution
Crown forest unavailable for harvest
timber harvesting land base
250
200
150
100
50
0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250
age in 10-year classes

Figure 5. Current age class composition -- Dawson Creek TSA forested land base, 2002.

The age class distribution of forested stands excluded from the timber harvesting land base also affects timber supply. These excluded areas can affect how much harvesting can be conducted and the pattern of the harvesting within the TSA by providing old-forest and biodiversity attributes. About 2% of the area outside the timber harvesting land base is occupied by stands older than 250 years. Less than 2% of the stands are 20 years or younger, 46% are between 21 and 100 years old, and 50% are between 101 and 250 years old.

Stands outside the timber harvesting land base change through natural disturbance events such as fire, heavy winds and pests. In the analysis, this disturbance was modelled by "harvesting" areas (with no contribution to projected timber supply) each decade. The objective of the "harvesting" is to mimic a more natural distribution of age classes (particularly old forest) throughout the forecast horizon, rather than allowing the forest to age continuously.

2 Information Preparation for the Timber Supply Analysis

2.2 Timber growth and yield

Two growth and yield models were used to estimate timber volumes for the Dawson Creek TSA analysis. The variable density yield prediction (VDYP) model* supported by the Ministry of Sustainable Resource Management, Terrestrial Information Branch, was used for estimating volumes in unmanaged coniferous stands and both unmanaged and regenerating deciduous stands. The table interpolation program for stand yields (TIPSY)*, developed by the B.C. Forest Service, Research Branch, was used to estimate yields for coniferous managed stands. In the analysis, managed stands were defined as coniferous stands aged 12 years or younger. Where regenerating stands included a mix of coniferous and deciduous species, yield curves were developed by combining values from TIPSY and VDYP.

Timber volume estimates* assume a specific utilization level, or set of dimensions, which establish the minimum sizes of trees and logs that are removed from a site. Utilization levels used in estimating timber volumes specify minimum diameters both near the base and the top of a tree as well as a maximum stump height.

Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" contains details on the definition of managed stands, utilization standards and the specific model versions used.

Volume estimation and prediction are subject to uncertainties related to inventories which form the basis for estimating site productivity, limited experience with second-growth in British Columbia, and the long time frame over which trees grow. Sensitivity analyses* described in Section 5, "Timber Supply Sensitivity Analyses," address the possibility that actual timber volumes may be different from estimates used in this analysis.

In 1997, a Vegetation Resources Inventory (VRI) was initiated for the Dawson Creek TSA. The inventory and associated analysis was completed over five years, and used ground sampling throughout the district to measure, among other things, the quantity and quality of timber, coarse woody debris*, plants, soils, and biogeoclimatic site series. The VRI revealed that the forest cover inventory was significantly underestimating timber volumes in the TSA. Prior to commencing this timber supply analysis, forest cover inventory attributes — namely age, height and stand volume — were adjusted based on VRI findings. Figure 6 shows the site index range in the Dawson Creek TSA, before and after adjusting the ages and heights.

Volume estimates for stands dominated by aspen were most affected by the inventory adjustment, with a 33% increase in total volume. Volume estimates for white spruce stands increased by an average of 5%. The technical details of the inventory adjustment are available in the document *Dawson Creek Timber Supply Area — Documentation of Vegetation Resources Inventory Interim Analysis, June 2000* and *— Addendum No. 2, May 2002,* available from the Ministry of Sustainable Resource Management, Terrestrial Resources Information Branch.

Sensitivity analysis described in Section 5, "Timber Supply Sensitivity Analyses," addresses uncertainty around estimates for existing stand yields.

Variable Density Yield Prediction model
An empirical yield prediction system supported by the Ministry of Sustainable Resource Management, designed to predict average yields and provide forest inventory updates over large areas (i.e., Timber Supply Areas). It is intended for use in unmanaged natural stands of pure or mixed species composition.

Table Interpolation Program for Stand Yields
A B.C. Forest Service computer program used to generate yield projections for managed stands based on interpolating from yield tables of a model (TASS) that simulates the growth of individual trees based on internal growth processes, crown competition, environmental factors and silvicultural practices.

Volume estimates (yield projections)
Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.

Sensitivity analysis
A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or base case.

Coarse woody debris
Logs and stumps that provide habitat for plants, animals and insects, and a source of nutrients for soil development.

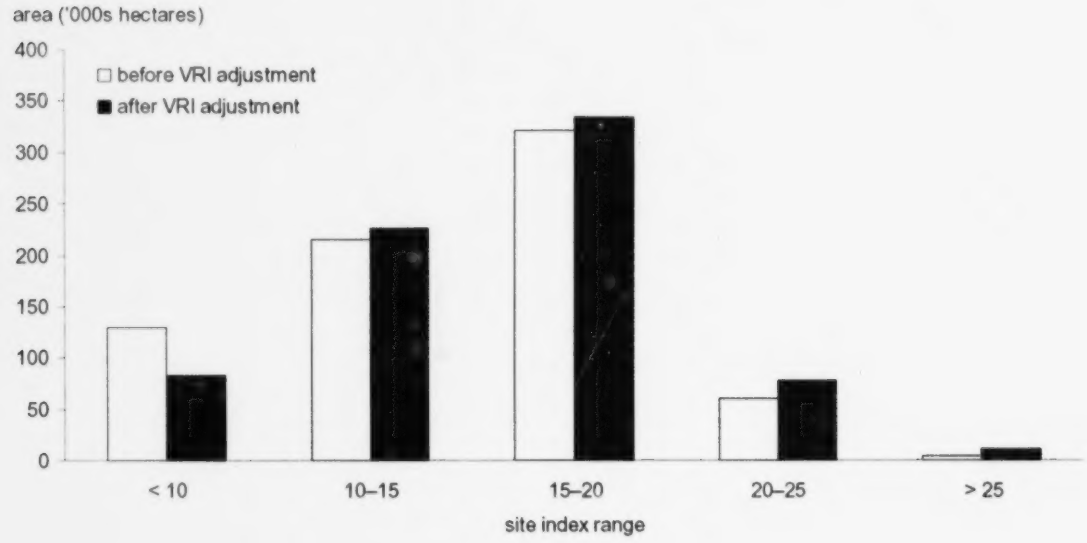


Figure 6. Range of site indexes, before and after the VRI adjustment — Dawson Creek TSA total forested land base, 2002.

Based on the adjusted volume estimates, the current timber inventory on the timber harvesting land base is approximately 140 million cubic metres. About 139 million cubic metres, or 98% of the volume on the timber harvesting land base are currently older than the minimum harvestable age (MHA).

2.3 Management practices

The data package for the Dawson Creek TSA was released in September 2000. Since no public input was received, no significant changes were made to the data package. The revised data package, which includes detailed descriptions of the management practices and the assumptions used to incorporate them into the analysis, is presented in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" of this document.

Timber supply depends directly on how the forest is managed for both timber and non-timber values. Therefore, levels of management activity must be defined for the timber supply analysis process. The *Forest Practices Code of British Columbia Act* and associated regulations guide forest management practices in the Dawson Creek TSA. The focus of the timber supply review is to assess timber supply based on current management practices as implemented for the area. Staff in the Dawson Creek Forest District provided descriptions for the following management practices:

- Separate management of the coniferous, deciduous and small pine land bases. The small pine land base consists of lodgepole pine stands that are currently greater than 80 years old and are between 17.5 and 19.4 metres in height. The coniferous land base comprises white spruce, pine and subalpine fir stands. The deciduous land base consists primarily of aspen stands. Separate harvest forecasts* were developed for each land base.
- Silviculture — reforestation activities required to establish free-growing* stands of preferred and acceptable tree species. Most areas in the Dawson Creek TSA are harvested using a clearcut with reserves harvesting system and restocked by planting or natural regeneration.
- Forest health and unsalvaged losses — unharvestable timber losses to fire, wind and pest (e.g., insect, root rot) damage are estimated to average approximately 58 900 cubic metres per year over the 250 year analysis horizon.
- Utilization levels — minimum sizes of trees, and logs to be removed during harvesting.

Harvest forecast
The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

Free-growing
An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.

- Cutblock adjacency* and green-up* — in the Dawson Creek TSA, approval of harvesting activities is contingent on previously harvested stands reaching a desired condition, or green-up (three metres in height for the integrated resource management (IRM)* area), before adjacent stands may be harvested. The purpose of the cutblock adjacency guideline is to prevent timber harvesting from becoming overly concentrated in an area. This guideline was modelled by limiting the area within the IRM zone that does not meet green-up conditions to a maximum of 33%.
- Maintenance of scenic values — visible evidence of harvesting must be kept within limits in some areas of the Dawson Creek TSA. The maximum proportion of each scenic area that may be covered by young stands that do not meet visual green-up requirements (five metres in height) varies according to the forest characteristics, the visual quality objectives (VQO) and the visual absorption capability (VAC) for each area. The permissible area below green-up age ranges from 1% for preservation VQOs* to 20% for modification VQOs*.
- Maintenance of forest cover for caribou habitat — applies to 132 940 hectares, or 18% of the timber harvesting land base. For these areas, there is a requirement to maintain a minimum of 44% of the total forested area greater than 140 years of age, of which at least 11% must be old seral*.

Cutblock adjacency
The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Green-up
The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.
Integrated resource management (IRM)
The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.

Preservation VQO
Alterations are generally not visible. Up to 1% of the visible landscape can be visibly changed by harvesting activity.
Modification VQO
Visible alterations may dominate the landscape, but should blend with natural features. Up to 25% of the visible area can be altered by harvesting activity.
Old seral
Old seral refers to forests with appropriate old forest characteristics. Ages vary depending on forest type and biogeoclimatic variant.

- Early seral* forest cover requirements are applied to approximately 108 500 hectares of the timber harvesting land base to simulate management objectives for priority grizzly bear habitat recommended in the LRMP.
- Important wildlife habitat, riparian areas and recreation values have been identified. To maintain ecological or other resource values, land has been partially or entirely excluded from the timber harvesting land base.
- Minimum harvestable ages (MHAs) identify the time expected for stands to grow to a minimum merchantable condition. Using conventional harvest systems such as "cut and skid", both coniferous and deciduous stands were considered merchantable when they attain a volume of 120 cubic metres per hectare. Where helicopter or cable logging is employed, stands were considered merchantable when they attained a volume 200 cubic metres per hectare. Actual harvest age is generally greater but never less than the minimum, and will depend on ages of other available stands, forest cover objectives* and overall timber harvest targets.
- Landscape-level biodiversity — to maintain biological diversity throughout a landscape unit, the *Forest Practices Code* prescribes targets for the proportion of the area in each biogeoclimatic (BEC) variant* that should be covered by stands with old-forest characteristics. In the Dawson Creek TSA, stands considered old forest range from 100 years to 250 years, depending on biogeoclimatic zone, natural disturbance type (NDT)* and prominent species group. Old and mature-plus-old seral requirements associated with draft biodiversity emphasis options (BEO) were applied to all draft landscape units in the analysis. See Section A.4.11, "Forest cover requirements" in Appendix A for details.
- Stand-level biodiversity* — to maintain biological diversity in forest stands, wildlife tree patches (WTP) are retained after harvesting. In the Dawson Creek TSA, the recommended WTP retention levels were applied by landscape unit, BEC zone and coniferous or deciduous content (see Appendix A, Section A.4.11.2, "Wildlife tree patches (WTP)").

Early seral
Stands are defined as early seral if they are younger than 40 years of age. An exception is deciduous-dominated stands in the Boreal White and Black Spruce biogeoclimatic zone, which are defined as early seral up to 20 years of age.

Forest cover objectives
Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see Cutblock adjacency and Green-up).

Biogeoclimatic (BEC) variant
A subdivision of a biogeoclimatic subzone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.

Natural disturbance type (NDT)
An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas subject to less frequent stand-initiating disturbances usually have more older forests.

Stand-level biodiversity
A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.

2 Information Preparation for the Timber Supply Analysis

Figure 7 shows the total Crown forest land base by management emphasis. The percentages add to more than 100% because some caribou management area overlaps with the integrated resource and visually sensitive areas. Figure 8 shows the visually sensitive areas by visual quality objective (VQO).

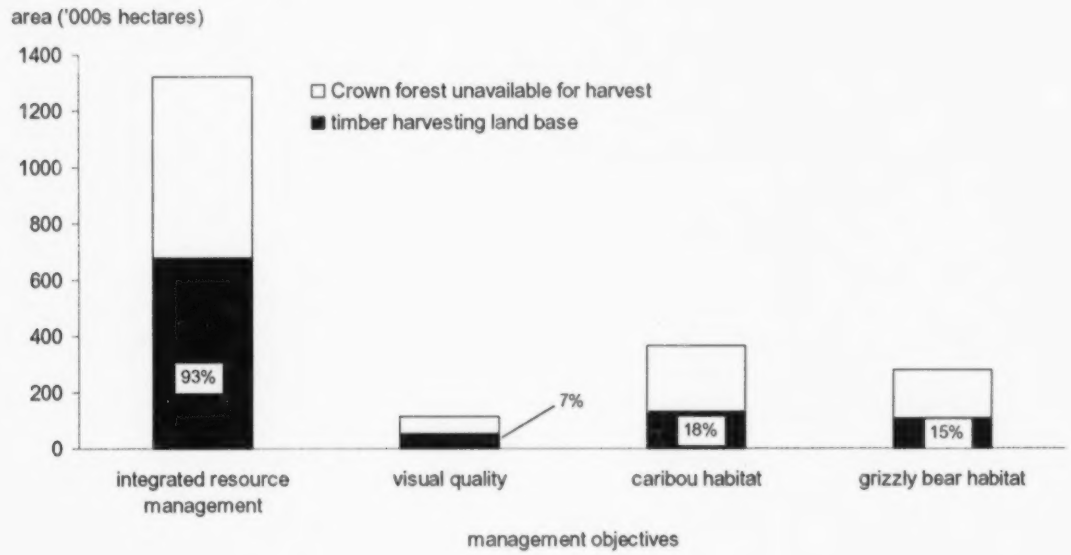


Figure 7. Crown forest land base by management emphasis — Dawson Creek, 2002.

Figure 8 shows the area within the TSA being managed for the various visual quality objectives (VQO). The forest area subject to VQOs is 114 044 hectares, approximately 9% of the total TSA forest area. On the timber harvesting land base, 54 386 hectares are subject to VQOs (7.1% of the timber harvesting land base).

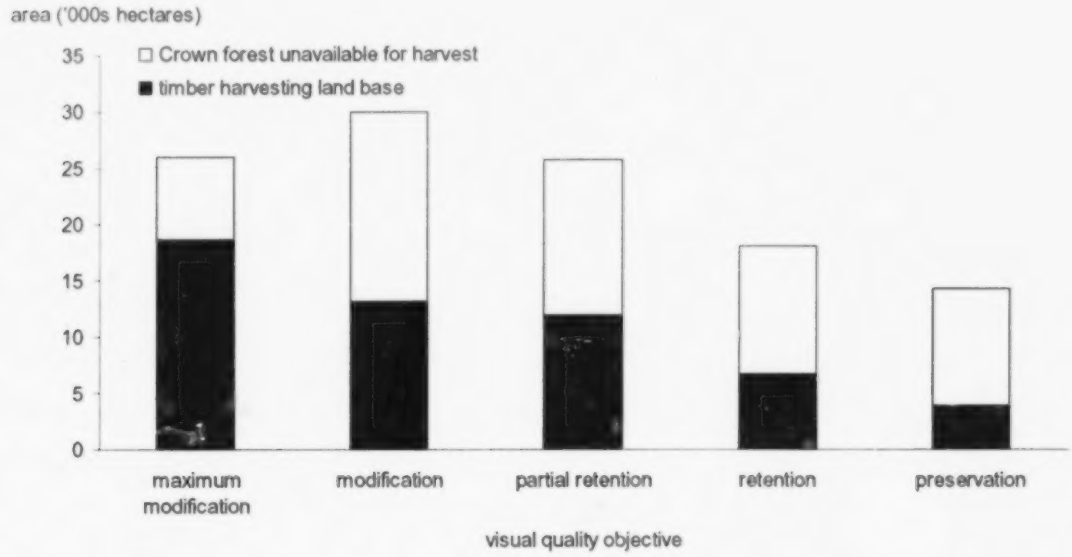


Figure 8. Area within the TSA managed for visual quality objectives (VQO) in the Dawson Creek TSA, 2002.

3 Timber Supply Analysis Methods

The purpose of this analysis is to model current forest management practices and examine the short- to long-term timber harvesting opportunities in the Dawson Creek TSA. A timber supply computer simulation model developed by the B.C. Forest Service (Forest Service Simulator (FSSIM) version 4.1) was used to aid in the assessment. A timber supply model, as distinct from a growth and yield model, assists the timber supply analyst in determining how a whole forest (collection of stands) could be managed to obtain a harvest forecast (supply of timber over time). The simulation model uses information about the timber harvesting land base, timber volumes and the management regime to represent how stands will grow and be harvested over a long period of time. Generally, the results for the first 250 years are shown graphically in this report because the harvest level remains constant after that time.

Similar to other models, the B.C. Forest Service model assumes that trees grow according to provided yield projections and are harvested according to either a volume target or a specified objective set by the analyst. The Forest Service model also allows the use of forest cover guidelines that specify the desired age composition of the forest. These guidelines can be used to examine the effects of green-up and old-forest prescriptions. For example, guidelines might specify a maximum percentage of the forest that can be younger than a specified green-up age or some minimum percentage of the forest that must be in older age classes to provide wildlife habitat.

Management assumptions* can be changed in the B.C. Forest Service simulation model to allow for the examination of management guidelines on timber supply. This type of analysis is used to determine the timber supply implication of a particular management regime. The results of the analysis are especially important in determining allowable cuts that will not restrict options of future resource managers, and that will assist local B.C. Forest Service staff to administer their programs according to relevant guidelines and principles. However, the results of the analysis are not meant to be taken as recommendations of any particular AAC.

The main results of the analysis are forecasts of potential timber harvests and timber inventory changes (ages and volumes) over time. Although this information gives field staff only limited guidance in the design of operational activities such as harvest block location and silviculture planning, it does help ensure that the timber harvest level supports sustainable forest management in the field.

Management assumptions
Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

4 Results

This section presents the results of the timber supply analysis for the Dawson Creek TSA. The base case harvest forecast* uses the most recent assessments of current forest management, the land available for timber harvesting, and timber yields as described in Section 2, "Information Preparation for the Timber Supply Analysis." The impacts of uncertainty in the inputs to the analysis will be discussed in Section 5, "Timber Supply Sensitivity Analyses." The base case provides only part of the timber supply picture for the Dawson Creek TSA, and should not be viewed in isolation of the sensitivity analyses.

The previous sections outlined the major changes in management assumptions since the 1994 Dawson Creek TSA analysis. Any comparison between this and the last analysis should acknowledge differences in management regimes, and related data and assumptions made at the time of each analysis. One of the major reasons the chief forester is required under the *Forest Act* to periodically review the timber supply and AAC is to account for changes in management, information and knowledge.

4.1 Base case harvest forecast

The base case harvest forecast for the Dawson Creek TSA represents current management as described in Appendix A of this report. Figure 9 shows the three components — coniferous, deciduous and small pine — which make up the base case harvest forecast.

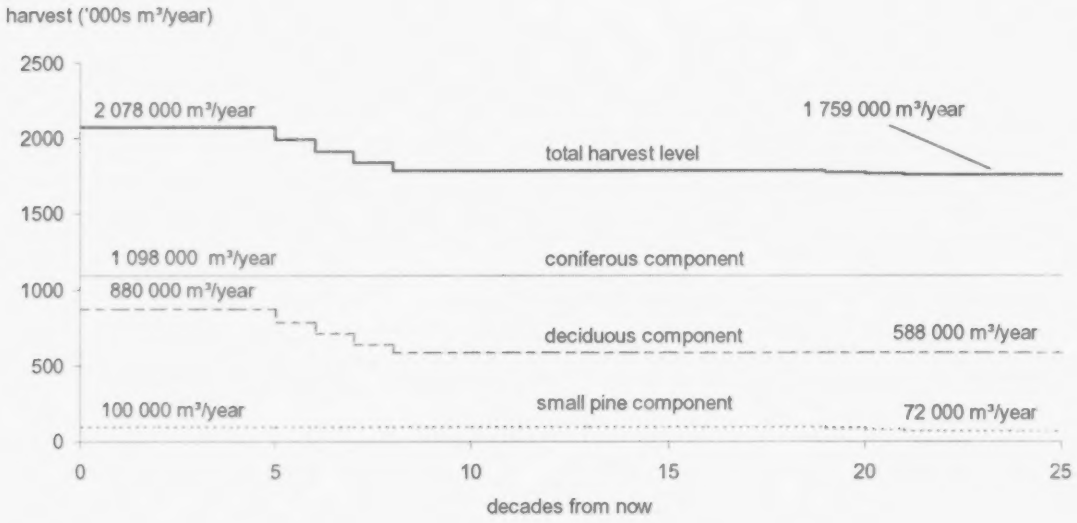


Figure 9. Base case harvest forecast — Dawson Creek TSA, 2002.

Base case harvest forecast
The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.

4 Results

The current AAC for the Dawson Creek TSA is 1 733 033 cubic metres (excluding woodlots). Of this AAC, 846 533 cubic metres are attributed to predominantly coniferous stands and 886 500 cubic metres to predominantly deciduous stands. The coniferous portion of this AAC also includes a 100 000 cubic metres contribution from small pine stands.

In this analysis the contribution from the small pine component is identified separately and is additional to the coniferous component. The base case shows that a harvest level of 2 078 000 cubic metres per year is possible for the first five decades after which the harvest gradually declines to a long-term level of 1 759 000 cubic metres per year.

The contribution from coniferous stands is 1 098 000 cubic metres per year for the entire planning horizon. Deciduous stands can sustain a harvest level of 880 000 cubic metres per year for the first five decades before declining by 10% per decade to a long-term harvest level* of 588 000 cubic metres per year. The small pine component can sustain a harvest level of 100 000 cubic metres per year for approximately 19 decades before declining to a long-term harvest level of 72 000 cubic metres per year.

4.2 Base case harvest forecast assumptions and dynamics

The assumptions used to develop the base case for the Dawson Creek TSA timber supply analysis are presented in this section. Where applicable the impacts of these assumptions are highlighted below:

Unsalvaged losses associated with the timber harvesting land base are estimated at 58 900 cubic metres per year. These losses have been applied over the entire planning horizon and are subtracted from all harvest forecasts shown in this report.

As previously discussed, the base case harvest forecast incorporates three specific components: coniferous, deciduous and small pine stands. The timber harvesting land base associated with each of these components is summarized as follows:

- coniferous — 429 440 hectares (59%);
- deciduous — 260 342 hectares (36%);
- small pine — 40 437 hectares (5%).

Lodgepole pine contributes to two of the components — the small pine harvest forecast and the coniferous harvest forecast. The timber harvesting land base associated with the small pine component was defined as those areas currently supporting pine stands greater than 80 years old and between 17.5 and 19.4 metres in height. By contrast, pine stands greater than 19.4 metres in height or having the potential to be greater than 19.4 metres in height by age 80 are included in the coniferous land base.

In the analysis, coniferous volume within deciduous-leading stands contributes to the overall deciduous harvest forecast. Likewise the deciduous volume within coniferous- or small pine-leading stands contributes to the overall coniferous- or small pine-leading components, respectively.

Natural stand disturbance is modelled by intentionally "harvesting" the non-timber harvesting land base — that portion of the productive forest that is unavailable for timber harvesting — throughout the forecast horizon.

Many forecasts other than those shown in the base case are possible for the three components. The criteria for selecting the base case harvest flows are described as follows:

- For all forecasts, attempt to maintain the current AAC for as long as possible.
- The initial harvest level for small pine is based on the assumption that 100 000 cubic metres per year of the total initial harvest level will come from small pine within the current coniferous AAC.

Long-term harvest level
A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.

4 Results

- The current coniferous AAC of 846 533 cubic metres per year can be met over the entire simulation period. At this level the growing stock* continually increases indicating a significantly higher stable level of harvest is possible. Since the harvest level is greater than the current AAC, an even-flow harvest forecast has been modelled for this component of the base case.

Stands identified in forest development plans are given the highest priority for harvest during the first 20 years of the simulation.

A relative-oldest-first harvest rule was assumed in the base case. Priority for harvest is highest for stands that are oldest relative to the applicable minimum harvestable age.

Figure 10 shows the transition from harvesting existing unmanaged stands to regenerating stands. For the first seven decades the harvest depends fully on existing stands; during decades eight through 15 the harvest becomes increasingly dependent on the contribution from managed stands. Given that only 8% of the timber harvesting land base is less than 20 years old, any change that affects the timing of the transition can affect the harvest forecast. The harvest forecast projects timber supply to reach the long-term harvest level well before regenerating stands dominate the harvest forecast.

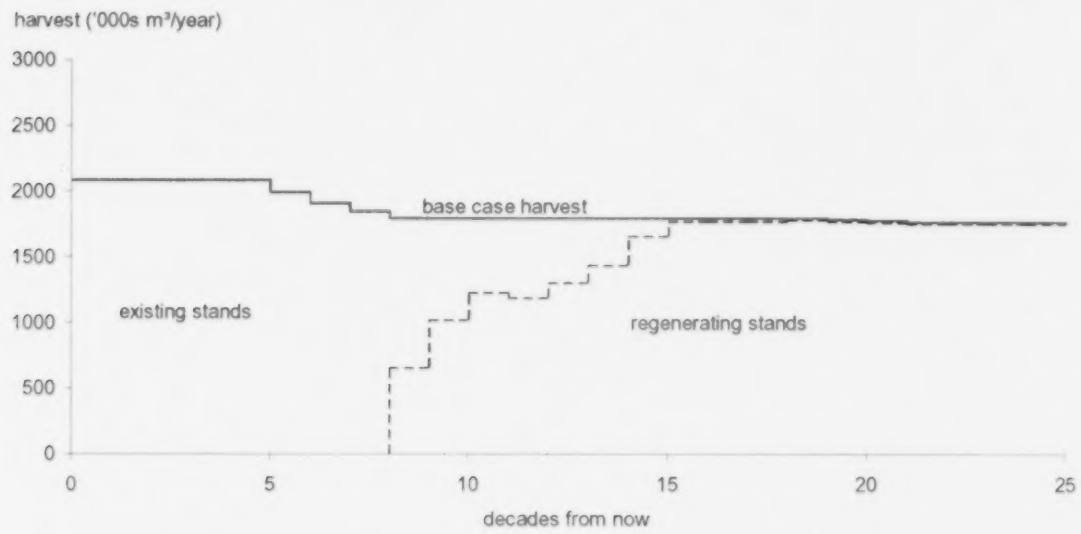


Figure 10. Existing and managed transition — Dawson Creek TSA, 2002.

Growing stock
The volume estimate for all standing timber at a particular time.

4 Results

Figure 11 shows the corresponding timber inventory volumes associated with the base case harvest forecast. Total growing stock on the timber harvesting land base is initially about 140 million cubic metres — about 98% of this is contained within stands that are currently considered merchantable, that is, older than minimum harvestable age. During the first 15 decades total growing stock declines to approximately 85 million cubic metres as older existing mature stands are harvested and replaced by younger second-growth stands.

Even though timber may be merchantable it may not be available for harvesting because the stands are required to satisfy other resource requirements, such as maintenance of scenic values, biological diversity, caribou habitat or green-up requirements, as defined in Appendix A.

The volume of timber initially available for harvest, after satisfying all the forest cover requirements applied in this analysis is about 56 million cubic metres. Available timber volume decreases to about 36 million cubic metres by decade nine. Figure 11 also shows the volume of timber harvested in the base case. The relatively constant difference between the volume harvested and the volume available suggests significant flexibility for managers planning harvesting operations in the near future, given current management assumptions.

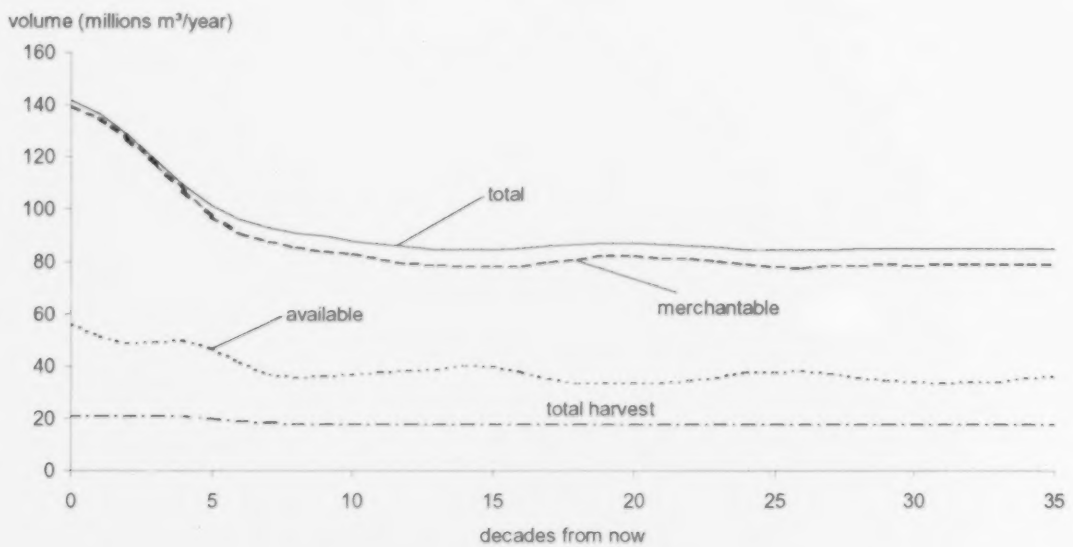


Figure 11. Total, merchantable and available growing stock — Dawson Creek, 2002.

4 Results

Figure 12 shows the merchantable growing stock by harvest component over a 250-year planning horizon for the Dawson Creek TSA. In the long term the relative contribution to the growing stock of each harvest component is largely a function of the proportion of the land base and the productivity differences associated with each harvest component.

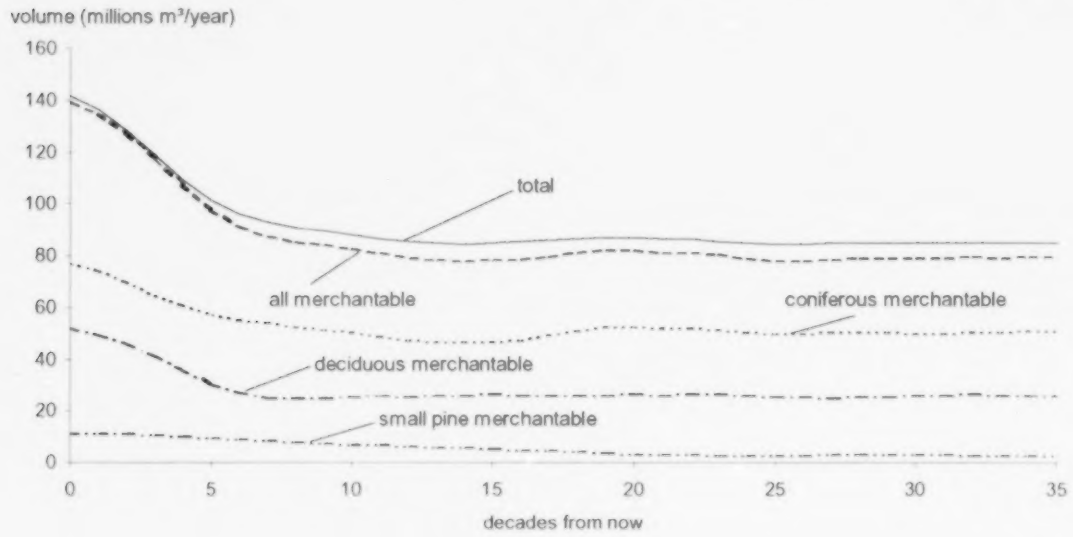


Figure 12. Total and merchantable growing stocks by harvest components — Dawson Creek TSA, 2002.

4 Results

4.3 Area, average volume and average age harvested

Figure 13 tracks the change in the area-weighted average age of stands harvested during the base case forecast horizon. During the first 80 years, the harvest comes almost entirely from older unmanaged stands. Average harvest ages during this period are approximately 156 years for coniferous stands and 119 years for deciduous stands. During the next 7 decades — between 80 years and 150 years — the average harvest age declines to less than 100 years, as an increasing proportion of the total harvest comes from younger regenerated stands. After 150 years virtually all the projected harvest in the base case forecast is from regenerated stands. During the remainder of the 250-year forecast, the average harvest age fluctuates between 90 and 110 years —significantly higher on average than the permissible minimum harvestable ages. Area-weighted average minimum harvestable ages for existing and regenerating stands are 73 and 65 years respectively.

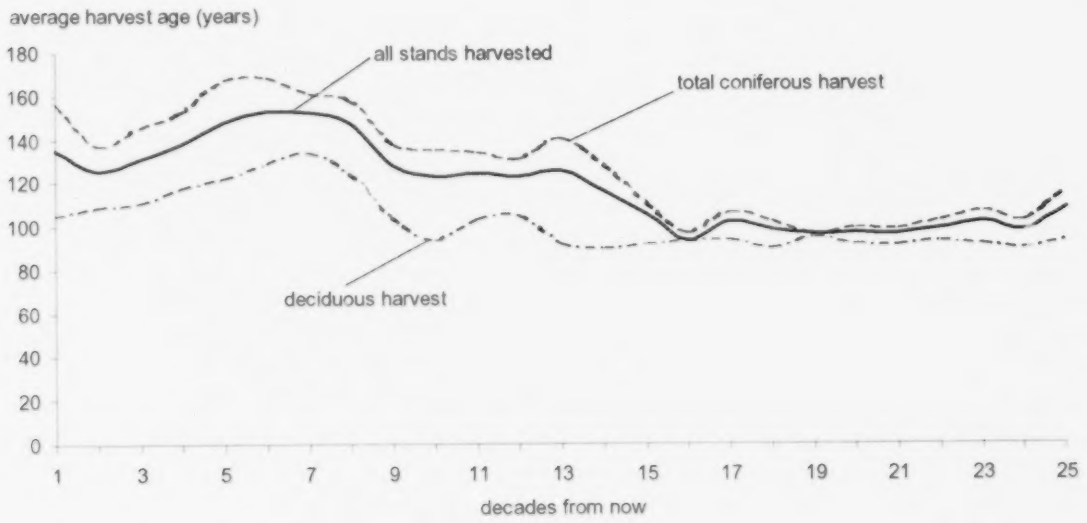


Figure 13. Average harvest age — Dawson Creek, 2002.

4 Results

Figure 14 shows the average volume per hectare harvested over the forecast period. These average volumes were derived using the total volume harvested including unsalvaged losses. Overall the average volume per hectare is forecast to remain relatively constant during the 250-year planning horizon. The average harvested volume per hectare for coniferous stands increases slightly over time from an average of about 305 cubic metres per hectare during the first 100 years to approximately 320 cubic metres per hectare during the last 50 years.

For deciduous stands, the average harvested volume per hectare declines from an average of about 290 cubic metres per hectare during the first 100 years to approximately 250 cubic metres per hectare at the end of the 250 year horizon.

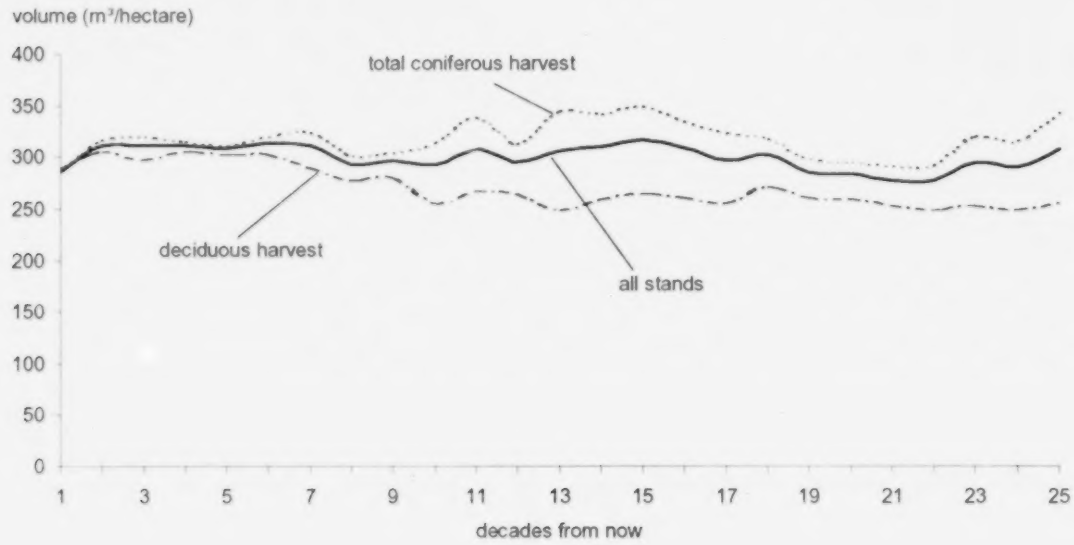


Figure 14. Average harvest volume, Dawson Creek TSA, 2002.

4 Results

Figure 15 shows the average area harvested over time for the coniferous, deciduous and small pine components of the base case. The average area harvested over the entire forecast horizon is approximately 6300 hectares per year. The average area harvested for each species group undulates significantly during the 250-year horizon. This reflects the variability in the average volume per hectare harvested and the initial age class distribution. When harvested stands have higher volumes, less corresponding area is required to achieve the same total volume harvested.

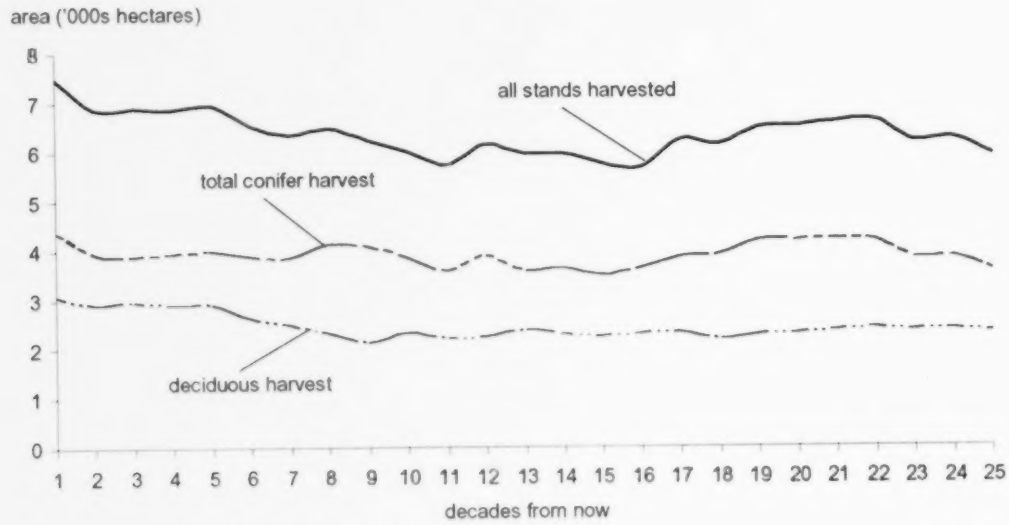


Figure 15. Average area harvested over time — Dawson Creek TSA, 2002.

4 Results

4.4 Age class profile over time

The charts in Figure 16 show how the age composition of the Dawson Creek TSA productive forest land base changes over the next 250 years under the base case harvest forecast.

There are 1 435 946 hectares of productive forest land base within the Dawson Creek TSA analysis area, of which 730 220 hectares (51%) make up the initial timber harvesting land base. The initial age class distribution reflects a number of historical events and management practices. There are proportionately few young stands within the timber harvesting land base, consistent with the limited harvesting history in the TSA.

Most of the productive forest land within the TSA is between 40 and 150 years of age due to large wildfires that occurred when there were no fire suppression measures.

The current age class composition of the timber harvesting land base is similar to the age class distribution of the productive forest area unavailable for harvest. About 15% of stands on the timber harvesting land base are above 140 years of age and less than 1% are above 250 years of age. Most older stands occur primarily in high elevation ecosystems that experience a lower frequency of natural disturbance.

Under current management assumptions, the age class distribution for the timber harvesting land base moves to a more even, regulated distribution over time.

The portion of the productive forest land base that is not available for timber harvesting does not age indefinitely. In the model, natural stand disturbance events such as fire and pests are acknowledged through area-control harvesting in the model as discussed in Section 4.2, "Base case harvest forecast assumptions and dynamics."

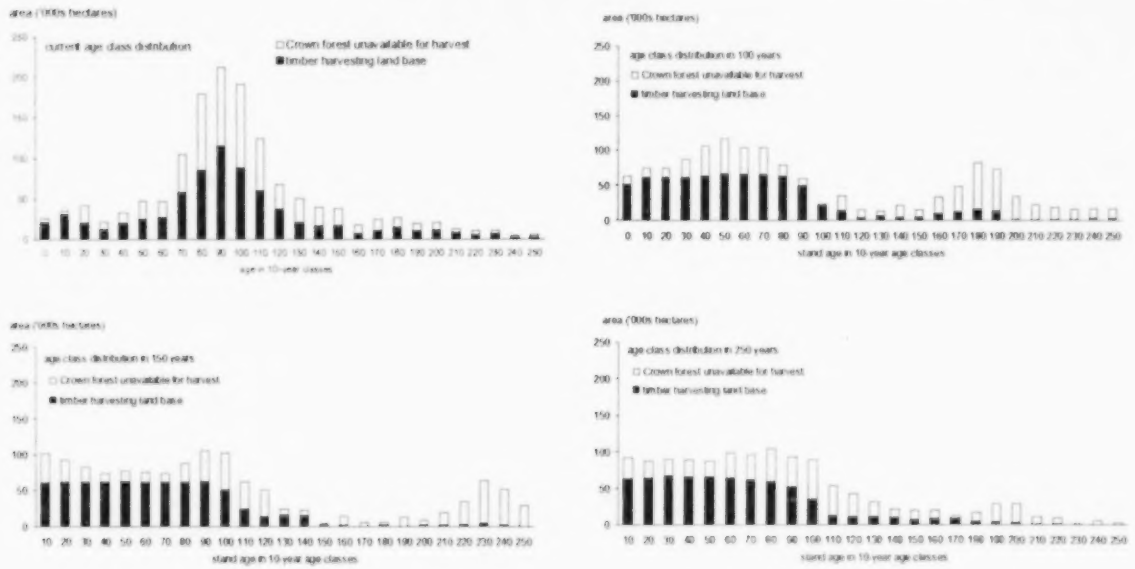

area ('000s hectares)
current age class distribution
Crown forest unavailable for harvest
timber harvesting land base
age in 10-year classes
area ('000s hectares)
age class distribution in 100 years
Crown forest unavailable for harvest
timber harvesting land base
stand age in 10-year age classes
area ('000s hectares)
age class distribution in 150 years
Crown forest unavailable for harvest
timber harvesting land base
stand age in 10-year age classes
area ('000s hectares)
age class distribution in 250 years
Crown forest unavailable for harvest
timber harvesting land base
stand age in 10-year age classes

Figure 16. Changes in age composition on the productive land base over time — Dawson Creek TSA base case, 2002.

5 Timber Supply Sensitivity Analyses

The best available information on forest inventories and management practices is used to analyse the timber supply implications of continuing with current management. However, forest management must also account for diverse and changing human values, the dynamics of complex ecosystems, and fluctuating and uncertain economic factors. As well, forests grow relatively slowly in terms of human life spans, so that decisions we make today have not only short-term but also long-term effects beyond the life spans of current decision makers. In such a context, we cannot be certain that all the data accurately reflect the current state of all values in the forest, how the forest will change, or how our management activities will affect the forest.

One important way to deal with this uncertainty is to revise plans and analyses frequently to ensure they incorporate up-to-date information and knowledge. Frequent planning and decision-making can help minimize any negative effects that may occur if decisions are based on inaccurate information. Frequent revision can also ensure that opportunities that become apparent from new information are not missed.

Another important way of dealing with uncertainty is to assess how values of interest, (for example, timber supply), could change if the information used in the analysis is not accurate. Sensitivity analysis is one way of evaluating how uncertainty could affect analysis results, and ultimately decision-making. Sensitivity analysis can highlight how small uncertainties associated with some variables may have large effects on timber supply projections, or conversely that large inaccuracies in other variables may have negligible effects. Also, sensitivity analysis may show that some variables affect timber supply more in the short term than in the long term, while others have the opposite effect. Sensitivity analysis can highlight priorities for collecting information for future analyses, and show which variables, and associated uncertainties, have the most significance for decisions. It can also clarify whether current best estimates provide a safe basis for decisions, or whether high uncertainty about important variables means more conservative decisions may be wiser.

In this section, results of a number of sensitivity analyses are discussed. Sensitivity analyses are intended primarily to test the relative change (i.e., high *versus* low sensitivity) in the harvest forecast resulting from changes in forest management assumptions and data used in the base case. Short term refers to the first 20 years of the harvest forecast, medium term is 21 to 100 years from now, and long term is after 100 years from now.

5 Timber Supply Sensitivity Analyses

5.1 Alternative harvest forecasts

The base case harvest forecast shown in Figure 9 was developed subject to the assumptions discussed in Section 4.2, "Base case harvest forecast assumptions and dynamics." Other forecasts are also possible including projections below the base case harvest levels. Two examples are provided in this section:

Increase coniferous and small pine harvest levels:

- Figure 17 demonstrates that it is possible to increase the initial coniferous harvest level by 10% to 1 208 000 cubic metres per year. This level can be maintained for three decades before declining to a long-term harvest level of 1 093 000 cubic metres per year in decade 4 — slightly lower than the even-flow level depicted in the base case. The total coniferous harvest over the planning horizon is slightly higher (0.8%) than achieved in the base case.
- The small pine harvest can be increased by 35% and maintained for 10 decades before declining by 10% per decade to a long-term harvest level of 72 000 cubic metres.
- The impact of increasing the initial harvest levels of the coniferous and small pine-leading stands has no impact on the deciduous forecast.

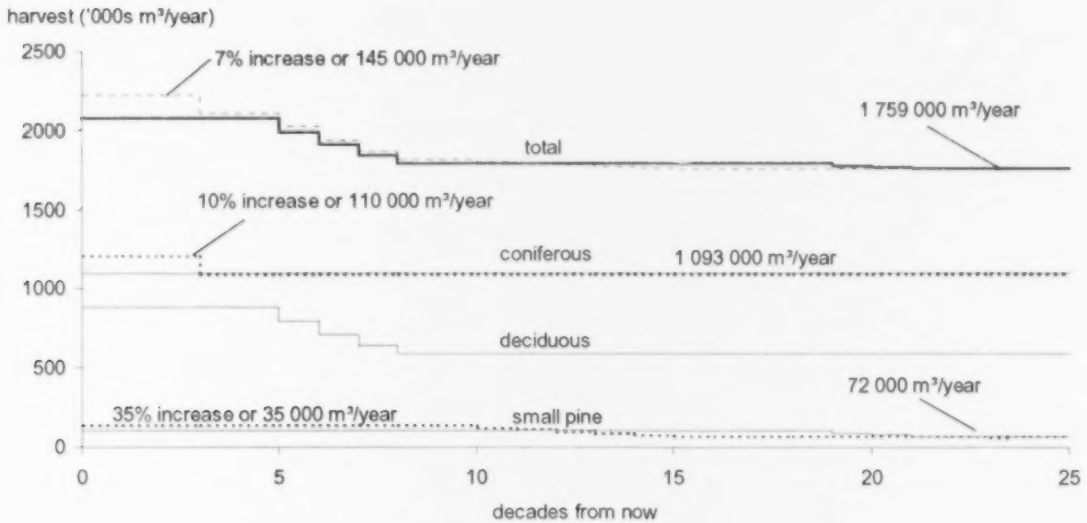


Figure 17. Increase initial coniferous harvest by 10% and small pine harvest by 35% — Dawson Creek TSA, 2002.

5 Timber Supply Sensitivity Analyses

Increase current deciduous harvest levels:

- Figure 18 illustrates that it is possible to increase the initial deciduous harvest level by 10% to 968 000 cubic metres per year. This harvest level can be maintained for 3 decades before declining by 10% per decade to the same long-term level as depicted in the base case.
- There is no significant difference in the total harvest over a 250-year planning horizon compared to the base case forecast.
- Increasing the initial deciduous harvest level has no impact on the coniferous harvest forecast over the planning horizon.

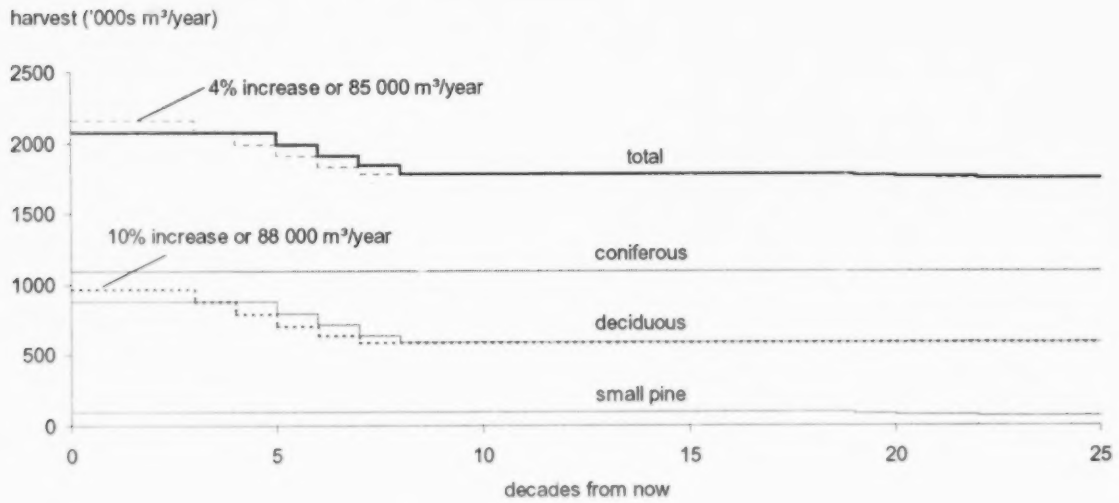


Figure 18. Increase initial deciduous harvest by 10% — Dawson Creek TSA, 2002.

Both these alternative harvest forecasts suggest that the existing stands could be harvested more rapidly in the short term than suggested by the base case, while still avoiding future timber supply disruptions. The forecasts illustrate that there is considerable flexibility in the choice of initial harvest level in all harvest components.

5.2 Uncertainty in the land base available for timber harvesting

Uncertainty in the estimated size of the timber harvesting land base results from factors such as fluctuations in timber prices, changes in harvesting and milling technology and land-use decisions.

The current timber harvesting land base is approximately 10% smaller than the last timber supply analysis for the Dawson Creek TSA. Less area is available primarily due to new parks, revised resource inventories (e.g., streams, ungulate winter range), different criteria for defining low productivity stands as well as incorporation of stand-level biodiversity considerations. However, additional areas are available due to revised operability criteria and application of the new Vegetation Resources Inventory (VRI).

Currently, there is no indication that the timber harvesting land base has been significantly over- or underestimated. However, a sensitivity analysis was performed to provide general information to help evaluate the implications of any new information that may become available before the AAC determination.

This section includes results of analyses in which the timber harvesting land base was increased and decreased by 10%, and in which a portion of the agricultural land reserve (ALR) was removed from the timber harvesting land base after harvest.

Figure 19 shows the impact of overestimating the area of the timber harvesting land base by 10%. In this sensitivity analysis, 10% of the timber harvesting land base is reassigned to areas that contribute to forest cover requirements but are not available for harvesting.

5 Timber Supply Sensitivity Analyses

Decrease the timber harvesting land base by 10%:

- The coniferous harvest level can be maintained for three decades before declining to a long-term harvest level of 988 000 cubic metres per year. Alternatively a flat line harvest forecast of 991 000 cubic metres per year — about 17% above the current coniferous AAC and 9.7% below the base case harvest level — can be maintained throughout the planning horizon.
- The initial deciduous base case harvest level of 880 000 cubic metres per year can still be maintained for up to three decades before declining by 10% per decade to a long-term harvest level of 531 000 cubic metres per year.
- The initial small pine harvest level of 100 000 cubic metres per decade can be maintained for 15 decades before declining by 10% per year to a long-term harvest level of 66 000 cubic metres per year.

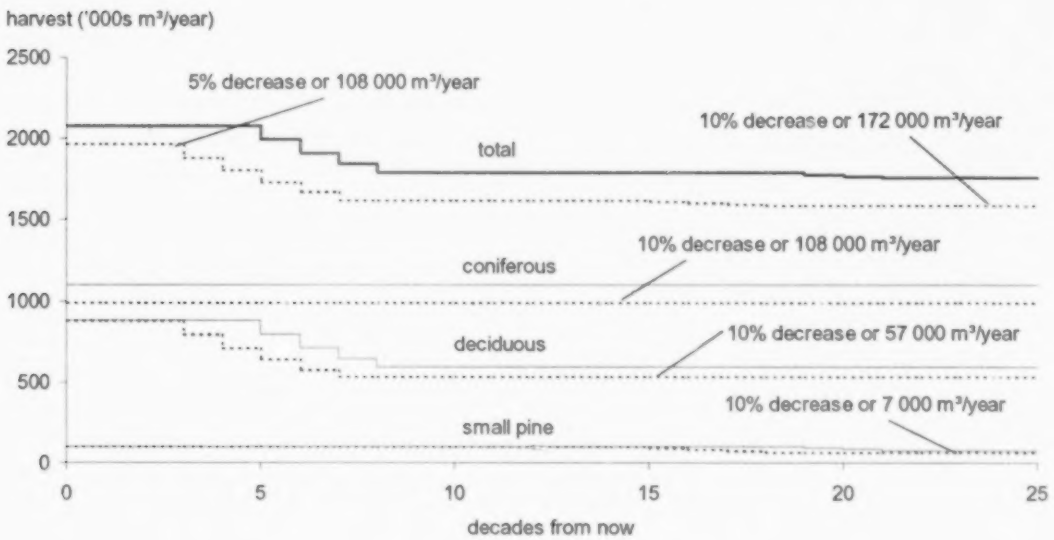


Figure 19. Harvest forecasts if timber harvesting land base is decreased by 10% — Dawson Creek TSA, 2002.

5 Timber Supply Sensitivity Analyses

Agricultural land reserve

In the Dawson Creek TSA, approximately 113 500 hectares of the timber harvesting land base is designated as agricultural land reserve (ALR) most of which supports deciduous-leading stands. Historically, the ALR has been part of the TSA area available for timber production, and once harvested, is regenerated and managed for forestry activities. Forest District staff advise that regeneration to timber is current practice and the base case modelled that assumption. However, it is possible that a proportion of ALR designated lands may in future be removed from the timber harvesting land base for agricultural purposes. Figure 20 illustrates the potential impact on timber supply of transferring 25% of ALR lands from the timber harvesting land base following harvest.

Remove 25% of agricultural land reserve designated lands following harvest:

- The maximum achievable even-flow coniferous harvest level is 1 081 000 cubic metres per year, approximately 1.5% lower than the base case.
- There is no short- or medium-term impact on the deciduous harvest forecast. The long-term harvest level is 532 000 cubic metres, about 10% lower than in the base case.
- The initial small pine harvest level of 100 000 cubic metres per year can be maintained for up to 17 decades before declining to 67 000 cubic metres, 7% lower than the long-term harvest level depicted in the base case.

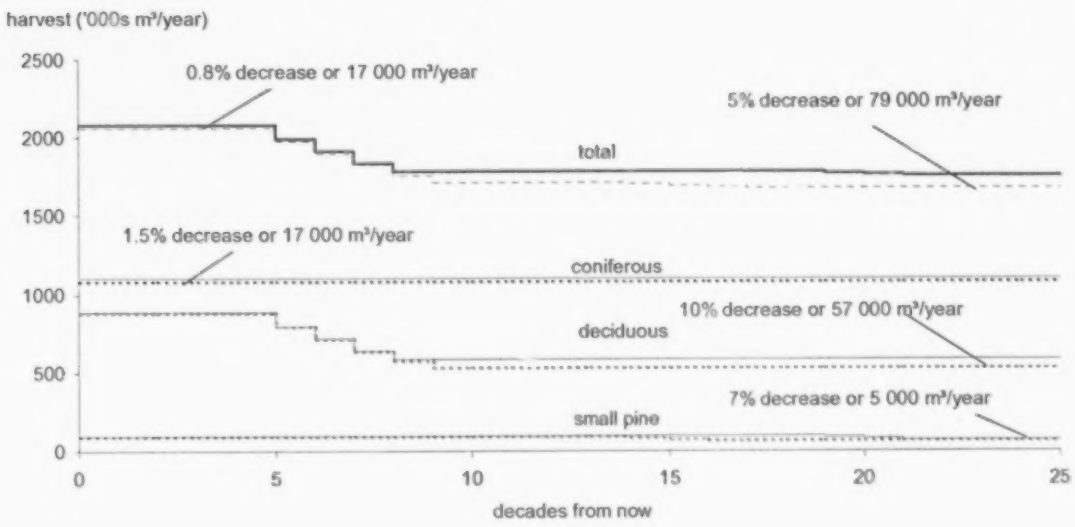


Figure 20. Harvest forecasts if 25% of agricultural land reserve lands are excluded from the timber harvesting land base following harvest — Dawson Creek TSA, 2002.

Increasing the timber harvesting land base by 10% (not shown):

- The coniferous harvest level can be increased by 10% to an even-flow harvest level of 1 208 000 cubic metres per year.
- The initial deciduous base case harvest level of 880 000 cubic metres per year can be increased by 10% to 968 000 cubic metres per year and maintained for 4 decades before declining by 10% per decade to a long-term harvest level of 647 000 cubic metres per year.
- The initial small pine harvest level of 100 000 cubic metres per year can be increased by 10% to 110 000 cubic metres and maintained for 18 decades before declining by 10% per year to a long-term harvest level of 80 000 cubic metres per year.

5.3 Uncertainty in the estimated existing stand yields

Timber volume estimates for existing unmanaged stands are subject to uncertainties in the forest inventory used to estimate timber volumes (i.e., estimated tree heights and stand ages), and the statistical process used to develop the equations for predicting forest growth and yield. The results of standard sensitivity analysis to test the impact of decreasing and increasing existing unmanaged stand yield estimates by 10% are presented in Figures 21 and 22. Harvest forecasts were developed using similar flow assumptions as employed in the base case.

5 Timber Supply Sensitivity Analyses

If existing unmanaged stand volumes are 10% lower than assumed in the base case:

- The maximum even-flow coniferous harvest forecast that can be maintained is 1 066 000 cubic metres, a 3% reduction from the base case forecast. Alternatively, if a non-declining forecast were allowed, the timber supply could increase to the base case level over the long term.
- The initial deciduous harvest level of 880 000 cubic metres per year can still be maintained for up to three decades before declining by 10% per decade to the long-term harvest level of 588 000 cubic metres.
- The initial small pine harvest level of 100 000 cubic metres can be maintained for up to 16 decades before declining to the long-term level described by the base case.

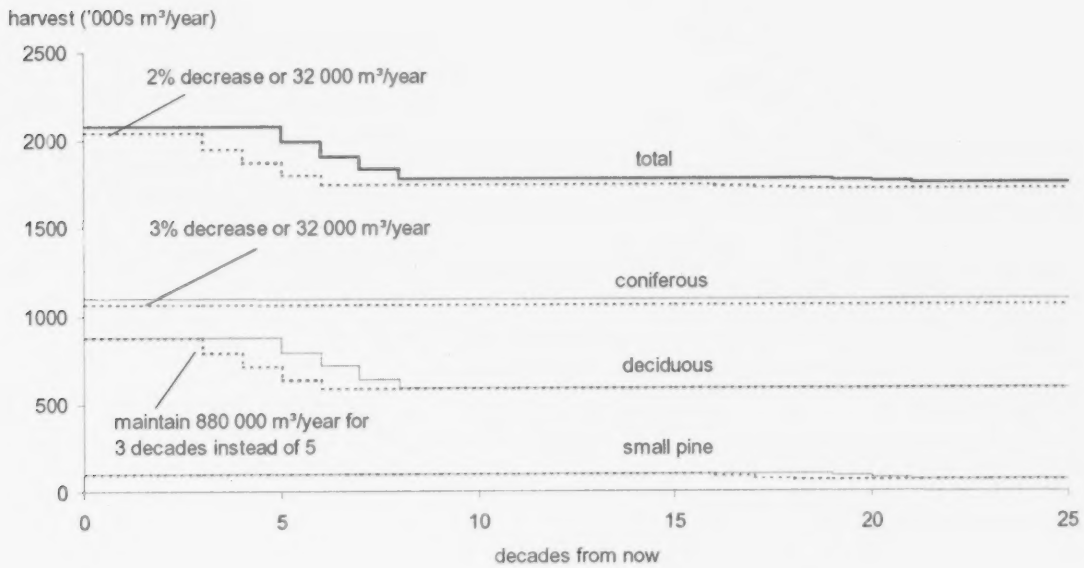


Figure 21. Harvest forecasts if existing unmanaged stand volumes are decreased by 10% — Dawson Creek TSA, 2002.

5 Timber Supply Sensitivity Analyses

If existing unmanaged stand volumes are 10% higher than assumed in the base case:

- The maximum even-flow coniferous harvest level cannot be increased above the base case harvest forecast. Regenerating stand yields limit the maximum even-flow to 1 098 000 cubic metres per year. Alternatively, the initial coniferous harvest level can be increased by 10% and maintained for 11 decades before declining to the even-flow harvest level of 1 098 000 cubic metres per year.
- The initial deciduous harvest level of 880 000 cubic metres per year can be maintained for an additional three decades compared to the base case forecast before declining by 10% per decade to the long-term harvest level of 588 000 cubic metres.
- The initial small pine harvest level of 100 000 cubic metres can be maintained for an additional 5 decades before declining to the long-term harvest level of 72 000 cubic metres per year depicted in the base case.

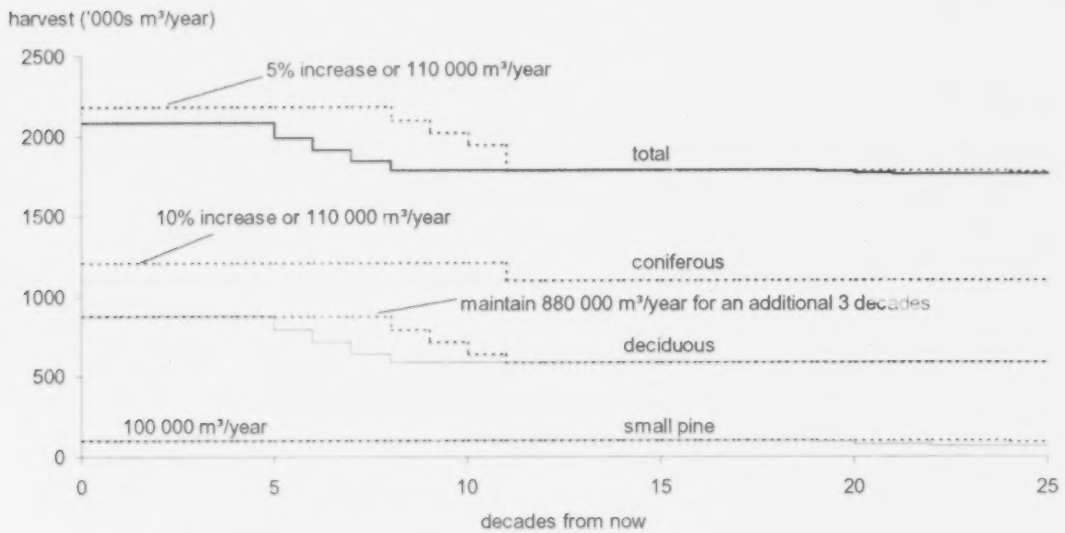


Figure 22. Harvest forecasts if existing unmanaged stand volumes are increased by 10% — Dawson Creek TSA, 2002.

5.4 Uncertainty in the estimated regenerating stand yields

Uncertainty in volume estimates for regenerating stands exists for similar reasons as those listed for existing stands (i.e., limitations and inaccuracies in the forest inventory, and growth and yield models). In addition, there is limited experience and data available for regenerating stands in B.C., including the Dawson Creek TSA where the history of harvesting and silvicultural operations is limited. There is also considerable uncertainty associated with the site productivity assigned to older unmanaged stands relative to the site productivity expressed by the stands once they regenerate after harvesting. This issue is examined in Section 5.7, "Uncertainty in site productivity estimates." Figures 23 and 24 illustrate the impacts of uncertainty in regenerated stands on the base case harvest levels.

<u>If regenerating stand volumes are 10% lower than assumed in the base case:</u>

- The maximum even-flow coniferous harvest level is reduced by 11% to 982 000 cubic metres.
- The initial deciduous harvest level of 880 000 cubic metres per year can be maintained for five decades before declining by 10% per decade to a long-term harvest level of 528 000 cubic metres per year, 10% lower than the long-term level described by the base case.
- The initial small pine harvest level of 100 000 cubic metres can be maintained for up to 16 decades before declining to a long-term harvest level about 10% lower than in the base case.

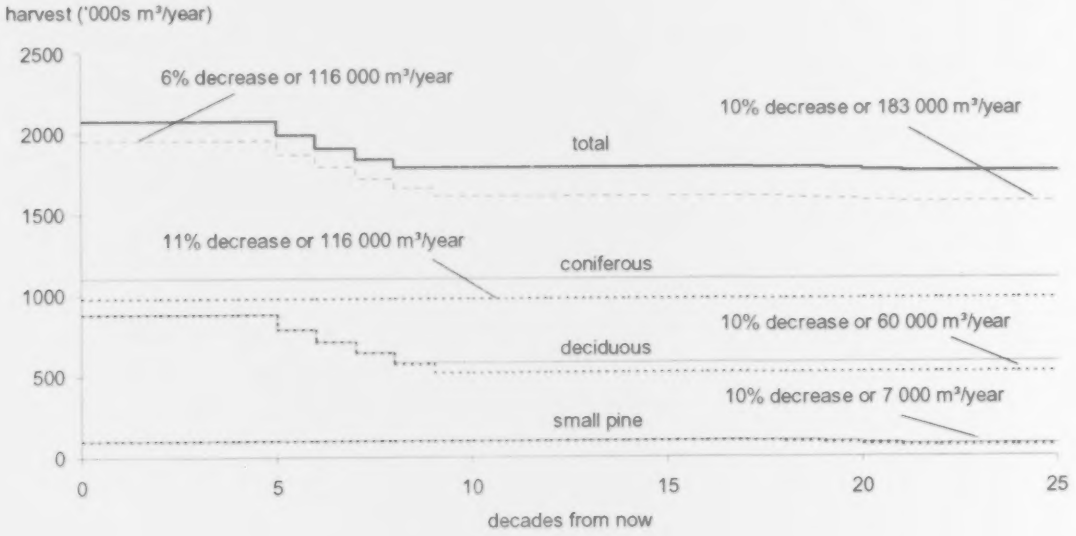


Figure 23. Harvest forecasts if regenerated stand volumes are decreased by 10% – Dawson Creek TSA, 2002.

5 Timber Supply Sensitivity Analyses

If regenerating stand volumes are 10% higher than assumed in the base case:

- The increase in regenerating stands is large enough to elevate the entire even-flow harvest forecast of the coniferous component by over 7%.
- The long-term harvest levels of the deciduous-leading and small-pine components can be increased by 10% and 7% respectively, while short- and medium-term supply is not affected.

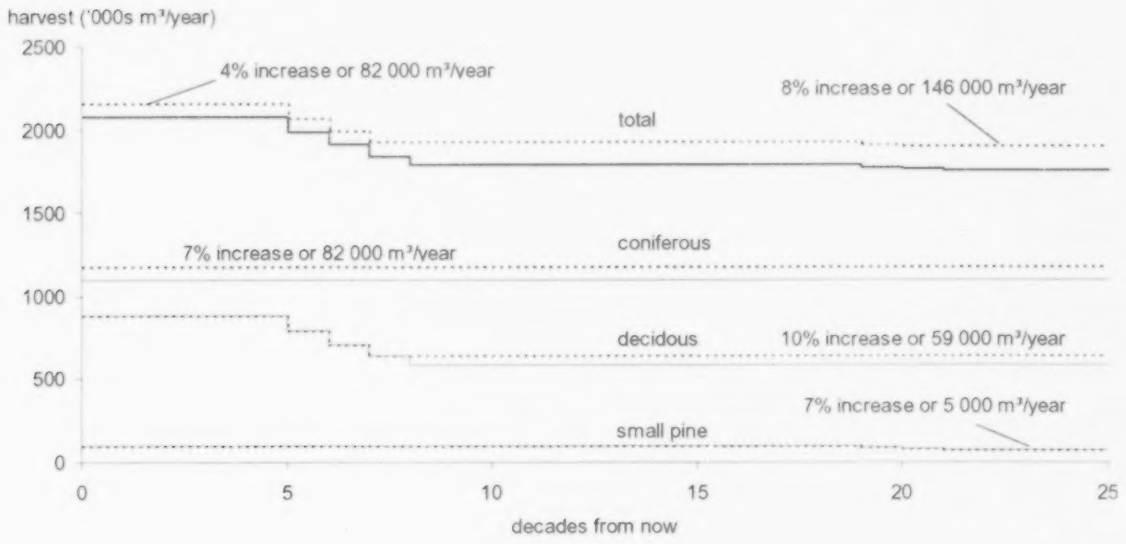


Figure 24. Harvest forecasts if regenerated stand volumes are increased by 10% — Dawson Creek TSA, 2002.

5 Timber Supply Sensitivity Analyses

5.5 Uncertainty in minimum harvestable ages

Minimum harvestable ages are an estimate of the time required for stands to reach a merchantable condition. They affect the time over which the harvest of existing stands must be rationed while regenerating stands grow to a merchantable age. The time at which stands will become merchantable is not known with precision because of uncertainty about the growth of regenerated stands, and an inability to foresee future conditions that will determine merchantability.

For this analysis, minimum harvestable age was defined as the age at which a stand attains a volume of 120 cubic metres per hectare. The resulting minimum harvestable ages are generally well below the age at which average stand growth is maximized (i.e., culmination of mean annual increment (MAI)*). In the short term for existing stands the area-weighted average minimum harvestable age for all stands across the entire TSA is approximately 73 years while culmination of MAI occurs on average at 123 years of age. In the long term, for regenerated stands, the average minimum harvestable age for the entire TSA is 65 years *versus* 105 years for culmination of MAI.

In the base case, if many stands had been harvested at or near minimum harvestable age the harvest forecast would have been significantly reduced over the long term as volume growth would not have been maximized. Since stands were not generally harvested in the model at their minimum harvestable age, increasing and decreasing minimum harvestable age by 10 years for each analysis unit had virtually no impact on the base case timber supply forecast for the Dawson Creek TSA. However, if stands are not made available for harvest until they approach their maximum growth potential (i.e., culmination of MAI), the base case harvest level would be disrupted. Figure 25 shows how the base case timber supply forecast would be affected if minimum harvestable ages are defined as the age at which 95% of culmination volume is achieved.

Mean annual increment (MAI)
Stand volume divided by stand age. The age at which average stand growth, or MAI, reaches its maximum is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.

5 Timber Supply Sensitivity Analyses

Minimum harvestable ages set at the age at which 95% of culmination of MAI is achieved:

- The base case harvest level is met for the first 170 years.
- Timber supply disruptions occur to the coniferous harvest forecast during decades 18 and 19. Minor disruptions to the small pine harvest occur during decades 19 to 21. There is no impact to the projected deciduous harvest levels.
- Reducing the coniferous base case harvest level by 2% is required to maintain a constant even-flow harvest forecast.
- The total growing stock over the long term is higher than in the base case.

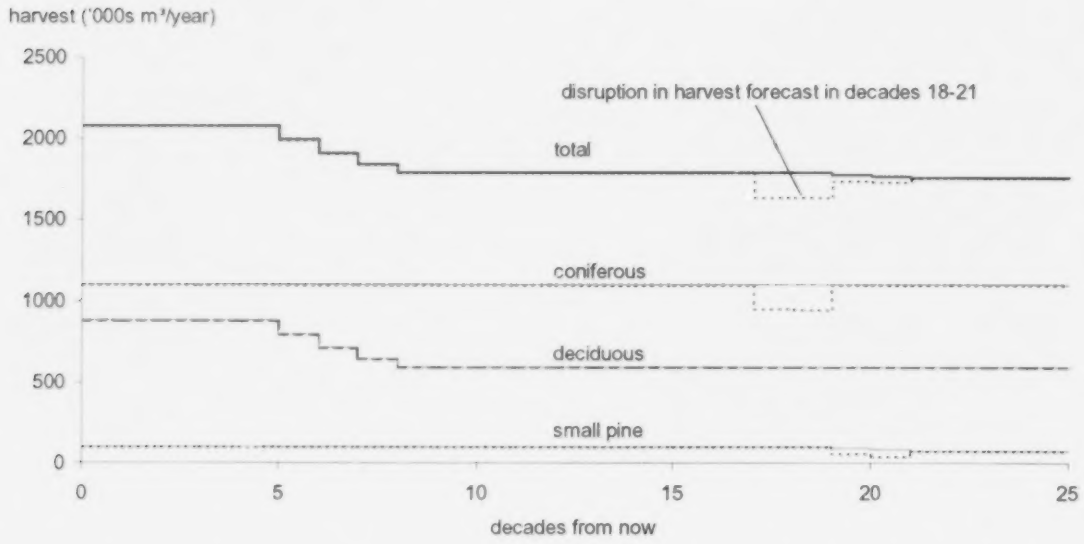


Figure 25. Harvest forecasts if minimum harvestable ages are defined as age at which 95% of culmination volume is achieved — Dawson Creek TSA, 2002.

5 Timber Supply Sensitivity Analyses

5.6 Impact of changing harvest scheduling priority

As discussed in Section 4.2, "Base case harvest forecast assumptions and dynamics", a relative-oldest-first harvest rule was used in the base case; priority for harvest was assigned to stands that were oldest relative to their applicable minimum harvestable age. However, because of physical and economic considerations, harvesting the oldest stands first does not always reflect operational practice. A sensitivity analysis was therefore performed to test the impact on timber supply if stands were chosen for harvest more randomly. For this sensitivity analysis, a random harvest rule was assigned to stands above the regional priority cutting ages. Deciduous-leading stands older than 60 years, lodgepole pine-leading stands older than 80 years, and spruce- and balsam-leading stands older than 100 years, were randomly chosen for harvest if they were otherwise eligible for harvest (above minimum harvestable age and not restricted from harvest due to forest cover requirements).

Figure 26 illustrates the significant impact of replacing the relative oldest-first harvest rule with a more random harvesting pattern. Short-, medium- and long-term timber supply is very sensitive to a change to a more random harvesting pattern in older stands.

5 Timber Supply Sensitivity Analyses

Stands above Prince George regional priority cutting ages are harvested randomly:

- For coniferous species the maximum even-flow harvest forecast is 901 000 cubic metres, almost 18% less than the base case projection. The initial harvest level of small pine-leading stands can be maintained for 13 decades before declining to 59 000 cubic metres, 18% lower than the base case level. This level is still above the current AAC allocated to coniferous-leading stands.
- For deciduous-leading stands the initial harvest level depicted in the base case can be maintained for four decades before declining by 10% per decade to a long-term harvest level of 434 000 cubic metres or 26% below the base case. With a more random harvesting pattern, younger stands that are still growing rapidly can be harvested before old stands which are growing more slowly, resulting in a significant volume loss.
- In the medium- and long-term the average harvest age resulting from a more random harvesting pattern is well below the average age of maximum productivity, more so than in the base case.

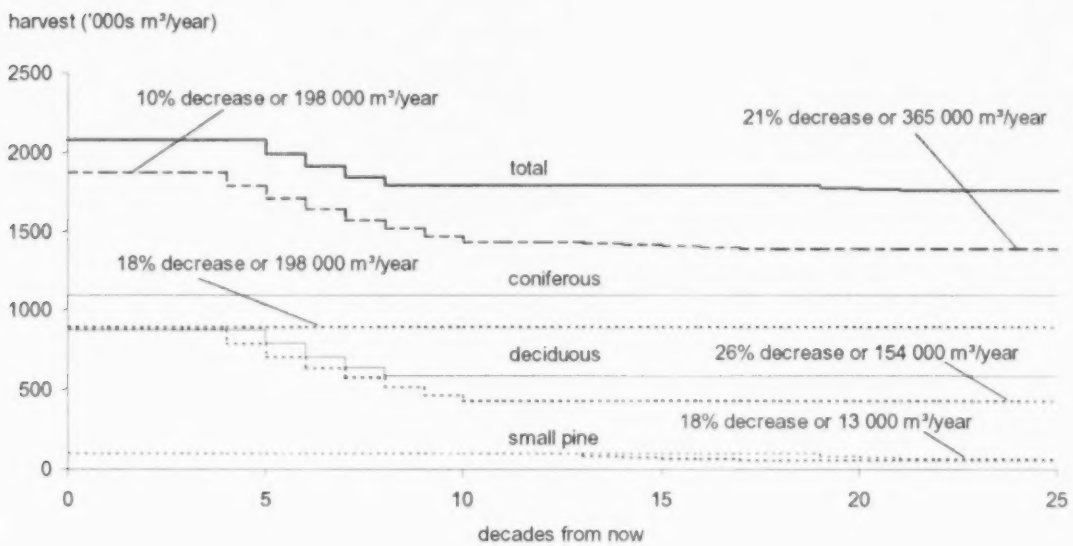


Figure 26. Harvest forecasts if stands older than regional priority cutting age are harvested randomly — Dawson Creek TSA, 2002.

5.7 Uncertainty in site productivity estimates

The productivity of a site largely determines how quickly trees will grow and is measured by site index. It therefore affects the timber volumes in regenerated stands, the time to reach green-up age, and the age at which stands achieve merchantable size.

The most accurate estimates of site productivity come from stands between 30 and 150 years old. At ages less than about 30 years, (particularly stands less than 15 years) the growth history of trees is too short to give accurate measurements of site productivity using conventional site index tools (site curves) and inventory estimates of height and age.

Site productivity estimates derived from older stands may also be incorrect as stands are well past the age of maximum height growth and have often been affected by disease, insects and top damage as they reach an advanced age. As a result, measurements from these trees can lead to underestimation of the growing potential of the site. If the site productivity estimates from these older stands are used to estimate the growth potential of young replacement stands, volume growth may also be underestimated.

The results of province-wide research suggest that the estimated productivity of sites currently occupied by old-growth stands may be significantly underestimated. Two Old-Growth Site Index (OGSI) studies applicable to timber supply forecasting are:

- *Site index adjustments for old-growth stands based on paired plots* (Nussbaum 1998). Data were obtained from paired plots installed in old-growth stands and adjacent logged and regenerated stands of the same productivity. Site index was estimated for both and comparisons were made. Results are available for coastal Douglas-fir, lodgepole pine, and interior spruce.
- *Site index adjustments for old-growth stands based on veteran trees* (Nigh 1998). The objective of the study was to develop site index adjustments for species not covered by the paired-plot project. The data for this study came from temporary and permanent plots with a veteran and main stand component. The site indices for the two components were estimated and an adjustment equation for each species was derived using linear regression analysis. The results of the study are considered less reliable than those from the paired-plot study.

Use of the results of the aforementioned studies is of interest in the Dawson Creek TSA, as stands older than 140 years comprise approximately 14% of the timber harvesting land base. To test the sensitivity of the base case harvest forecast to uncertainty about site index estimates, site indices of these older stands were adjusted using the paired-plot results (interior spruce and lodgepole pine) or veteran-tree results (balsam). No OGSI adjustments were applied to deciduous analysis units because there are is no significant area of deciduous stands older than 140 years. Timber supply analysis inputs affected by changes in estimated future productivity (i.e., managed stand volume estimates, green-up ages and minimum harvestable age) were recompiled based on average adjusted site productivity. Table 5 compares the average forest inventory-based site index for each old-growth analysis unit to those defined using the OGSI adjustments.

5 Timber Supply Sensitivity Analyses

Table 5. Average analysis unit site index based on forest inventory and OGSI information — Dawson Creek TSA, 2002

Analysis unit	Area (hectares)	Original inventory site index	Site index following VRI adjustment	Site index following OGSI adjustment
Spruce-medium	11 160	12.4	15.5	20.5
Spruce-poor	63 348	6.7	8.9	18.5
Balsam-poor	26 572	8.5	8.7	16.4
Pine-medium	1 243	15.6	13.1	19.9
Small pine-medium	2 210	12.8	10.9	19.5

Results of the OGSI sensitivity analysis are presented in Figure 27. The potential overall harvest level is 5.3% higher than the base case during decades 1 to 5 and 6.7% higher in the long term. Old-growth site index adjustments are not included in the base case since there is little local site productivity data or long-term monitoring of regenerated stands to support the adjustments. However, the results of the sensitivity analysis do provide insight into the possible trends associated with site productivity estimates for the Dawson Creek TSA and indicate that timber supply may be higher than projected in the base case.

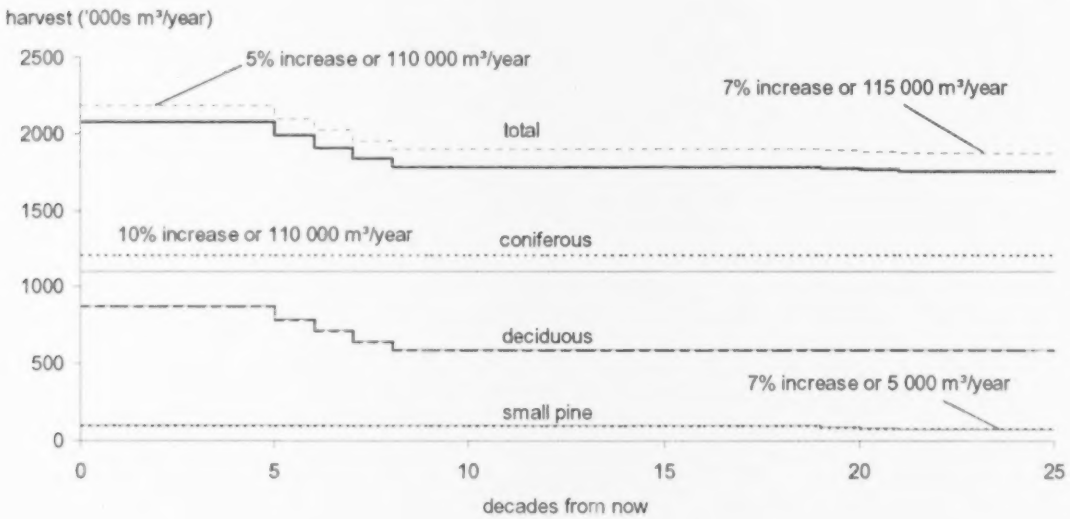


Figure 27. Harvest forecasts if old-growth site index adjustments are applied to stands older than 140 years — Dawson Creek TSA, 2002.

5 Timber Supply Sensitivity Analyses

5.8 Impact of the vegetation resources inventory adjustments

In 1995 an inventory audit completed in the Dawson Creek TSA reported that mature timber volumes of existing stands may be underestimated by up to 19% on average. It was also recognized that some of the original forest cover inventories for the TSA were out of date. In response, the Ministry of Forests initiated a new inventory procedure called the vegetation resources inventory (VRI) in 1997.

Ground sampling measurements were collected during 1998-2001 and final analysis of the VRI was completed earlier this year. The analysis focussed on developing statistically-based height, age and volume adjustment factors for deciduous, spruce, pine, and subalpine fir-leading stands. These adjustments were used in the timber supply analysis and are summarized in Table A-2. of Appendix A.

Application of the adjustment factors in the timber supply analysis increased volume estimates of existing stands within the forested land base by approximately 15% on average. The adjustments also increased the area-weighted average site index by approximately 0.7 metres. As a result, more stands met the minimum productivity criteria; the timber harvesting land base assumed in the base includes approximately 6000 hectares of stands that otherwise would have been excluded as non-merchantable forest had no VRI adjustments been made.

A sensitivity analysis was performed to investigate the impact of the VRI adjustments on the base case forecast. The results are illustrated in Figure 28.

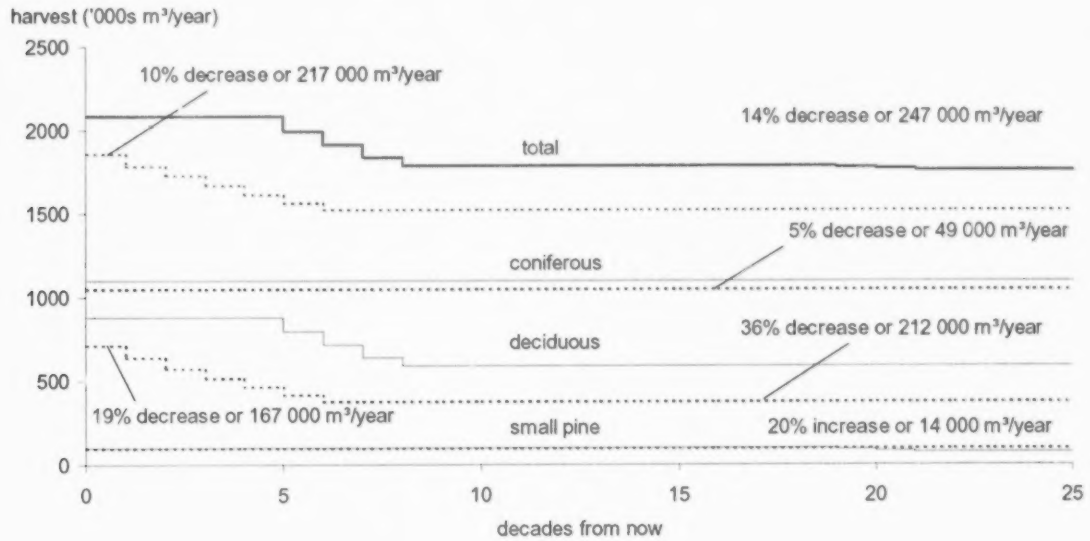


Figure 28. Harvest forecasts if vegetation resources inventory (VRI) adjustments are not applied — Dawson Creek TSA, 2002.

5 Timber Supply Sensitivity Analyses

No vegetation resources inventory (VRI) adjustments applied:

- The timber harvesting land base is reduced by 6023 hectares because fewer stands meet the minimum productivity criteria assumed in the base case.
- The total short-term harvest level is approximately 10% lower than projected in the base case. Medium- and long-term timber supply are about 20 and 14% lower respectively than in the base case forecast.
- The VRI volume adjustment ratios were largest for deciduous stands and hence have a proportionately greater impact on deciduous harvest levels than on coniferous levels. Moreover, the initial deciduous harvest level projected in the base case cannot be achieved.
- The long-term harvest level of small pine stands is approximately 20% higher than the base case level because significantly more (24%) pine stands meet the age and height criteria used to define small pine.
- Timber supply impacts are largely the combination of lower yield projections (particularly deciduous-leading stands), a smaller timber harvesting land base and changes in the distribution of site productivity.

5.9 Uncertainty in the volume estimates for small pine stands

As described in Section 4.2, "Base case harvest forecast assumptions and dynamics", small pine stands were defined as pine-leading stands older than 80 years and between 17.5 and 19.4 metres in height. In the analysis, stand attributes were modified using the appropriate vegetation resources inventory age and height adjustment ratios before defining which stands meet the small pine criteria. The volume curves for these stands (derived using VDYP) were then increased (approximately 45% on average) using the VRI-derived volume adjustment ratios.

Given the high proportion of available growing stock relative to the initial harvest level (100 000 cubic metres per year), small pine stands are converted to managed stands in the base case over a relatively long period. In the model, mature stands continue to accrue volume as they age well beyond 120 years before being harvested. Some existing stands are not converted to regenerating stands until decade 15. In reality, it is likely that due to successional processes, these older stands will become increasingly susceptible to fire, disease and insect damage and will yield considerably less volume than suggested by the base case assumptions.

In addition, district and licensee staff indicate that there is considerable variability in existing small pine stand attributes such as age, height, volume, and stocking. Moreover, the average volumes and the ages at harvest, as projected in the model, are not consistent with local field experience.

A sensitivity analysis was therefore performed to investigate the impact of a reducing the volumes of existing unmanaged small pine stands by 45%. The results are illustrated in Figure 29.

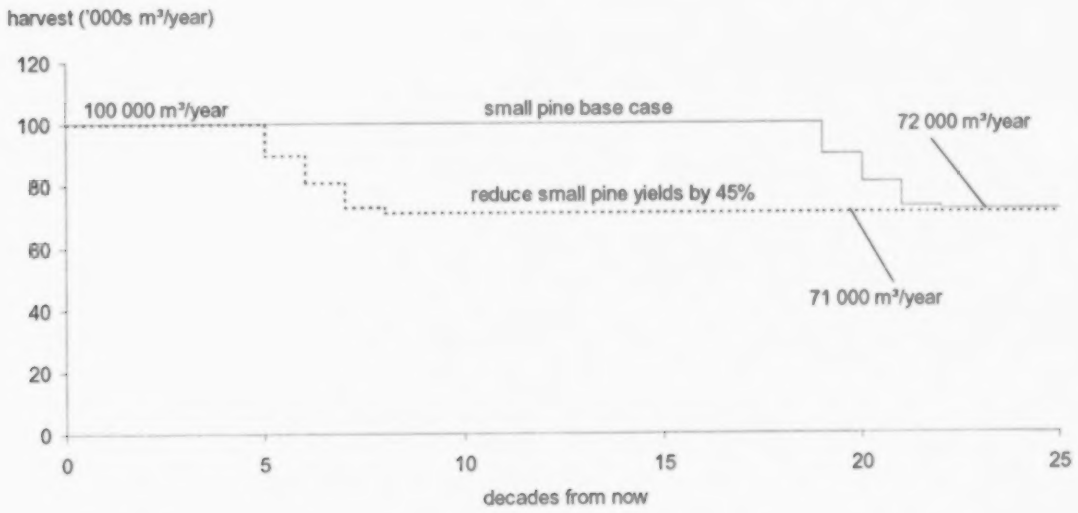


Figure 29. Harvest forecast if existing unmanaged stand volumes of small pine stands are reduced by 45% — Dawson Creek TSA, 2002

Reduce existing unmanaged small pine yields by 45%:

- Average harvest volumes of existing stands during the first 5 decades are about 185 cubic metres per hectare compared to over 300 cubic metres per hectare in the base case.
- Transition from unmanaged to regenerating stands occurs during decades 8 to 10 — much earlier than decade 15 as projected in the base case.
- The initial harvest level of small pine can be maintained for 5 decades compared to 19 decades in the base case.

5.10 Summary of sensitivity analyses

Table 6 summarizes the results of sensitivity analyses completed for the Dawson Creek TSA. The table lists the differences between each sensitivity analysis and the base case in both the short and long terms. The figures provide a quantitative basis for comparing the relative impact of various uncertainties.

Differences between the base case harvest forecasts and the sensitivity analysis results over the mid-term are not provided. Except where noted, the coniferous harvest forecasts project an even-flow harvest level. In all cases, the deciduous and small pine assumed a 10% rate of decline between the initial harvest level and the long-term harvest level. Where applicable, the decade during which the decline from the initial level is identified. The table includes several results not previously discussed due to the small or negligible effects on timber supply.

5 Timber Supply Sensitivity Analyses

Table 6. Summary of sensitivity analysis impacts for the Dawson Creek TSA

Variable/issue	Harvest component	Impact of sensitivity analysis relative to the base case		
		Per cent increase (decrease) from base case level in short term	Number of decades later (earlier) than base case before decline	Per cent increase (decrease) from base case level in long term
Alternative harvest forecasts (Section 5.1)				
	Coniferous	10.0	3	Nil
	Deciduous	10.0	(2)	Nil
	Small pine	35.0	(9)	Nil
Decrease area of timber harvesting land base by 10% (Section 5.2)				
	Coniferous	(9.8)	N/A	(9.8)
	Deciduous	Nil	(2)	(9.7)
	Small pine	Nil	(4)	(10.0)
Exclude 25% of ALR areas following harvest (section 5.2)				
	Coniferous	(1.5)	N/A	(1.5)
	Deciduous	Nil	0	(9.6)
	Small pine	Nil	(5)	(6.9)
Increase area of timber harvesting land base by 10% (Section 5.2)				
	Coniferous	10.0	N/A	10.0
	Deciduous	10.0	(1)	10.0
	Small pine	10.0	(1)	10.0
Decrease existing stand volumes by 10% (Section 5.3)				
	Coniferous	(2.9)	N/A	(2.9)
	Deciduous	Nil	(2)	Nil
	Small pine	Nil	(3)	Nil
Increase existing stand volumes by 10% (Section 5.3)				
	Coniferous	10.0	11	Nil
	Deciduous	Nil	3	Nil
	Small pine	Nil	5	Nil
Decrease regenerating stand volumes by 10% (Section 5.4)				
	Coniferous	(10.6)	N/A	(10.6)
	Deciduous	Nil	0	(10.2)
	Small pine	Nil	(1)	(9.7)
Increase regenerating stand volumes by 10% (Section 5.4)				
	Coniferous	7.5	N/A	7.5
	Deciduous	Nil	0	10.0
	Small pine	Nil	0	7.0
Assume MHA equivalent to age at which 95% of culmination of MAI is achieved (Section 5.5)				
	Coniferous	(2.0)	N/A	(2.0)
	Deciduous	Nil	0	Nil
	Small pine	Nil	(2)	Nil
Change harvest scheduling priority (Section 5.6)				
	Coniferous	(18.0)	N/A	(18.0)
	Deciduous	Nil	(1)	(26.2)
	Small pine	Nil	(6)	(18.2)

(continued)

Table 6. Summary of sensitivity analysis impacts for the Dawson Creek TSA (concluded)

Variable/issue	Harvest component	Impact of sensitivity analysis relative to the base case		
		Per cent increase (decrease) from base case level in short term	Number of decades later (earlier) than base case before decline	Per cent increase (decrease) from base case level in long term
Apply OGSI adjustments to stands >140 years (Section 5.7)				
	Coniferous	10.0	N/A	10.0
	Deciduous	Nil	0	0.3
	Small pine	Nil	0	7.2
Increase minimum harvestable ages by 10 years (Section 5.5)				
	Coniferous	Nil	N/A	Nil
	Deciduous	Nil	0	Nil
	Small pine	Nil	(1)	Nil
Decrease minimum harvestable ages by 10 years (Section 5.5)				
	Coniferous	Nil	N/A	Nil
	Deciduous	Nil	0	Nil
	Small pine	Nil	0	Nil
15% yield reduction on 30% of grazing areas[a]				
	Coniferous	Nil	N/A	Nil
	Deciduous	(2.4)	0	(2.4)
	Small pine	Nil	0	Nil
VQO allowable denudation set to minimum point in range[a]				
	Coniferous	(0.9)	N/A	(0.9)
	Deciduous	Nil	0	(0.9)
	Small pine	Nil	(1)	(0.5)
VQO allowable denudation set to maximum point in range[a]				
	Coniferous	0.1	N/A	0.1
	Deciduous	Nil	1	0.9
	Small pine	Nil	0	Nil
Landscape-level biodiversity — assume 45/45/10 weighted BEOs[a]				
	Coniferous	0.1	N/A	0.1
	Deciduous	Nil	0	Nil
	Small pine	Nil	0	Nil
Reduce yields by 10% on one-third of analysis units where strip shelterwood employed[a]				
	Coniferous	(2.5)	N/A	(2.5)
	Deciduous	Nil	0	Nil
	Small pine	Nil	0	Nil
No disturbance on forested area outside of timber harvesting land base[a]				
	Coniferous	1.5	N/A	1.5
	Deciduous	Nil	1	2.0
	Small pine	Nil	0	0.7
Increase green-up heights by one metre				
	Coniferous	Nil	0	Nil
	Deciduous	Nil	0	(0.1)
	Small pine	Nil	0	Nil

(a) Not discussed in Section 5 due to small impacts.

6 Summary and Conclusions of the Timber Supply Analysis

Timber supply was assessed for the Dawson Creek TSA and specific harvest forecasts for coniferous-, deciduous- and small pine-leading stands were investigated in detail. The base case projection suggests that a total harvest level of 2 078 000 cubic metres per year could be maintained for up to five decades before declining to a steady long-term harvest level of 1 759 000 cubic metres per year.

Small pine stands were defined as lodgepole pine stands older than 80 years, and between 17.5 and 19.4 metres in height. The analysis suggests that it is possible to harvest 100 000 cubic metres per year of small pine for up to 19 decades before declining by 10% per decade to a long-term harvest level of 72 000 cubic metres per year.

The coniferous forecast includes the contribution from interior spruce- and subalpine fir-dominated stands as well as lodgepole pine stands that are, or have the potential to grow to at least 19.5 metres tall by age 80 years. Results suggest that the timber supply associated with coniferous stands can be maintained at 1 098 000 cubic metres per year over the entire forecast horizon.

For deciduous stands, the results of this analysis suggest that the current deciduous AAC of 880 000 cubic metres per year (adjusted to account for woodlots) can be maintained for up to five decades. Timber supply then declines by 10% per decade to a long-term harvest level of approximately 588 000 cubic metres per year in decade nine.

The timber supply analysis examined the impact of increasing the initial harvest levels for each harvest component by increments of 10% or more. The analysis suggests that the initial coniferous harvest level can be increased by 10% and maintained for up to three decades without disrupting long-term timber supply. Initial increases of 10% and 35% are possible for the deciduous and small pine harvest components, respectively, with no disruptions to long-term timber supply. The high proportion of merchantable growing stock relative to the current harvest level can provide significant flexibility and a buffer against uncertainties that affect timber supply.

Inclusion of new vegetation resources inventory information was a key feature of the timber supply analysis. Statistically-based height, age and volume adjustment factors for spruce-, pine-, subalpine fir- and deciduous-leading stands were applied to the forest cover inventory and incorporated into the associated yield projections. In the timber supply analysis a sensitivity analysis was performed to provide insight into the effects of the VRI adjustments on the timber harvesting land base and projected timber supply.

Without application of the VRI adjustments, the area of the timber harvesting land base would be 6023 hectares smaller because fewer stands would meet the minimum productivity criteria assumed in the base case. Without the VRI adjustments, the total short-term harvest level is approximately 10% lower than projected in the base case, while medium- and long-term timber supply are about 20% and 14% lower, respectively, than in the base case. Because the volume adjustments ratios are typically larger for deciduous-leading stands than for coniferous stands, application of the VRI has a proportionately greater impact on deciduous harvest levels than on the coniferous forecast.

Sensitivity analyses were performed to test the potential impact of uncertainties in inventory, growth and yield and current forest management assumptions. The analyses showed that uncertainties in harvest scheduling priority, the size of the timber harvesting land base, existing and regenerating stand yield estimates, and site productivity estimates have the largest impacts on the base case forecast.

A relative-oldest-first harvest rule was assumed in the base case. However, because of physical and economic considerations, harvesting the oldest stands first does not always reflect operational practice. Sensitivity analysis illustrated that applying a more random approach to harvesting has significant timber supply impacts throughout the forecast horizon. Overall timber supply was reduced by 10% in the short-term and up to 21% in the long-term compared to the base case projection.

Several sensitivity analyses were done to explore the impact on timber supply of uncertainty in the timber harvesting land base. Standard analyses were done to test the impact of increasing and decreasing the size of the timber harvesting land base by 10%. In addition, the potential impact of removing a proportion of areas identified as agricultural land reserve (ALR) was explored. The analysis showed that excluding 25% of the ALR area from the timber harvesting land base following harvest primarily impacts long-term timber supply, and in particular the deciduous component.

6 Summary and Conclusions of the Timber Supply Analysis

Short-term timber supply is sensitive to changes that influence the amount of timber available from existing unmanaged stands, because the base case harvest relies almost entirely on harvests from these stands for the next 80 years. Sensitivity analysis showed that if existing stand volumes were 10% lower than assumed in the base case, the maximum even-flow coniferous harvest would have to be reduced by only 3%, while the deciduous harvest level could still be maintained for up to 3 decades before declining. In the Dawson Creek TSA, uncertainty in existing stand volumes primarily affects medium-term timber supply, during the transition from existing to regenerating stands.

Uncertainty in regenerating stand volumes primarily affects medium- and long-term timber supply. If regenerating stand volumes were 10% higher than estimated in the base case, long-term timber supply would increase by about 8% compared to the base case forecast. By contrast, a reduction in regenerating stand volumes reduced total long-term timber supply by approximately 10%. In the case of reduced volumes, a coniferous even-flow harvest level of 982 000 cubic metres per year (16% above the current AAC), could be achieved for the entire forecast horizon.

Approximately 14% of the timber harvesting land base comprises stands that are older than 140 years of age. Sensitivity analysis examined the uncertainty associated with site productivity estimates by applying provincial old-growth site index (OGSI) adjustments to stands older than 140 years. The timber supply analysis suggests that the base case harvest level may be underestimated by up to 7% in the long term on account of this factor.

Uncertainties and issues with small to negligible impacts on timber supply included: allowable denudation rates within visually sensitive areas; minimum harvestable age; reduced yields on areas used for livestock grazing (i.e., community pastures, grazing leases and permits), potential yield reductions in areas managed using strip shelterwood silvicultural systems; and, natural disturbance outside of the timber harvesting land base.

Visual quality objectives apply to only 7% of the timber harvesting land base and productive forest outside the timber harvesting land base helps to meet most of the visual objectives.

Increasing or decreasing the minimum harvestable ages assumed in the base case by 10% did not affect timber supply primarily because on average, minimum harvestable ages are well below the average ages at harvest in the base case projection.

Forest cover requirements used to approximate the effects of cutblock adjacency guidelines did not affect timber supply, largely because of the significant flexibility to move among different areas within the TSA. During all periods of the forecast, there was a relatively high proportion of available timber relative to the timber harvest target.

An additional sensitivity analysis was performed to further review the timber supply implications of uncertainty about volumes in existing small pine stands. District and licensee staff indicate that there is considerable variability in small pine stand attributes such as age, height, volume and stocking. Moreover, the average volumes and the ages at harvest, as projected in the base case, are not consistent with local field experience. The sensitivity analysis therefore explored the potential impact of a significant reduction (45%) to the existing yield curves. The analysis showed that the initial small pine harvest level projected in the base case (100 000 cubic metres per year) could still be maintained for 5 decades.

Finally, it is recognized that mixed-wood stands comprise a large proportion of the productive forest within the Dawson Creek TSA. However, the timber supply analysis did not attempt to address the complex issues associated with the successional patterns of the boreal mixed-wood forest in the TSA. In the analysis it was assumed that these stands will continue to contribute to the coniferous or deciduous harvest depending on their current species composition. Given the extent of these stands in the TSA and the results of local study and investigation elsewhere in the province, the issue of complex stand dynamics and its impact on timber supply remains a significant source of uncertainty in the Dawson Creek TSA. Although our understanding of complex stand dynamics and growth and yield is currently limited, new information and emerging modelling techniques will aid to reduce this uncertainty in future analyses.

7 Socio-Economic Analysis

The impact of timber supply adjustments on local communities and the provincial economy is an important consideration in the timber supply review. The socio-economic analysis compares the level of forestry activity currently supported by timber harvested from the Dawson Creek TSA to the level of activity that the TSA could support as the timber supply moves towards its long-term harvest level.

The socio-economic analysis examines harvest levels as projected in the base case harvest forecast and is not intended to examine alternative management scenarios.

The socio-economic analysis consists of the following:

- a profile of the current socio-economic setting;
- a description of the Dawson Creek TSA forest industry; and
- an analysis of the socio-economic implications of the base case harvest forecast.

The socio-economic analysis considers the current and projected levels of forestry activity associated with the Dawson Creek TSA within the context of regional timber supplies and production capacity. It does this by examining the profile of the region and the local forest industry; and by assessing employment and income implications of the timber harvesting levels projected in the base case.

The analysis includes estimates of the employment and income impacts associated with timber supply analysis projections by three main sectors: harvesting and other woodlands-related, processing, and silviculture. Employment is measured in person-years*. Employment income is calculated using average industry income estimates.

Data on direct employment, harvest levels, and fibre flows were obtained by surveying licensees and mill operators. The information was used to estimate harvesting, processing and silviculture direct employment averages associated with the harvest and the proportion of workers living in the area. The estimates of local and provincial harvesting, processing, and silviculture direct employment were then used to determine ratios of employment per 1000 cubic metres of timber harvested.

Indirect and induced employment figures were calculated using the Dawson Creek TSA and provincial employment multipliers* developed by the Ministry of Finance. Indirect impacts result from direct businesses purchasing goods and services; induced impacts result from direct employees purchasing goods and services. Employment coefficients* per 1000 cubic metres were also determined for the indirect and induced impacts.

To estimate the level of employment that could be supported by alternative harvest rates, projected timber supply levels were multiplied by the calculated employment coefficients. It should be noted that employment coefficients are based on current productivity, harvest practices and management assumptions and will not likely reflect industry conditions decades into the future. As such, the employment estimates can only be viewed as general indicators.

Person-year(s)
One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.

Employment multiplier
An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

Employment coefficient
The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.

7 Socio-Economic Analysis

7.1 Current socio-economic setting

The Dawson Creek TSA forms part of the Dawson Creek Forest District. Tree Farm Licence (TFL) 48, held by Canadian Forest Products Ltd., comprises the remaining portion of the district. The labour force and population statistics quoted below reflect the forest district.

7.1.1 Current population and demographic trends

In 2001, the population of the Dawson Creek Forest District was approximately 26,449 people (see Table 7).[1] The largest community in the forest district is Dawson Creek with 2001 population of 10,754 people. Other communities located in the forest district include Chetwynd with a 2001 population of 2,591, and Tumbler Ridge with a population of 1,851. Other smaller communities include Hudson's Hope and Pouce Coupe.

From 1996 to 2001, the population of the Dawson Creek Forest District declined by about 10%.[2] BC Stats population projections for the Peace River Regional District and Peace River South Local Health Area indicates further declines in population through 2005 in the southern Peace River, but a slight increase (about 2.6%) for the larger Peace River Regional District.[3] Part of the reason for the recent decline was the reduced production levels and final closure in August 2000 of the Quintette open-pit coal mine located in Tumbler Ridge.

Table 7. Dawson Creek forest district population statistics, 1991-2001

	1991	1996	2001	% change 1996-2001
Dawson Creek	11,298	11,125	10,754	-3.3
Chetwynd	2,933	2,980	2,591	-13.1
Tumbler Ridge	4,794	3,775	1,851	-51.0
Hudson's Hope	1,010	1,122	1,039	-7.4
Pouce Coupe	853	894	833	-6.8
Rural — Peace River Regional District Census Subdivisions D, E	8,429	9,305	8,999	-3.3
Peace River Regional District	54,844	56,477	55,080	-2.5
Dawson Creek Forest District	28,929	29,447	26,449	-10.2
British Columbia	3,282,910	3,882,043	4,096,894	5.5

Source: Census of Canada 1991, 1996, 2001. BC Stats Population Section.

(1) Census of Canada, 2001. Data provided by BC Stats.

(2) Census of Canada, 1996, 2001. Data provided by BC Stats.

(3) BC Stats, Population Section, B.C. Ministry of Finance and Corporate Relations. Estimate for 2005 based on 1996-2005 population growth rates for the Peace River South Local Health Area.

7.1.2 Economic profile

Data from 1996 indicates that the Dawson Creek Forest District is one of the more diversified regions in the province, relying on several sectors for economic stability.[4] However, sectoral changes since 1996 will alter this characteristic. Figure 30, which provides the dependency figures by sector, is based on data from the 1996 Census, subsequently it may not reflect the current 2002 local economy. Census 2001 labour force data will not be available until 2003.

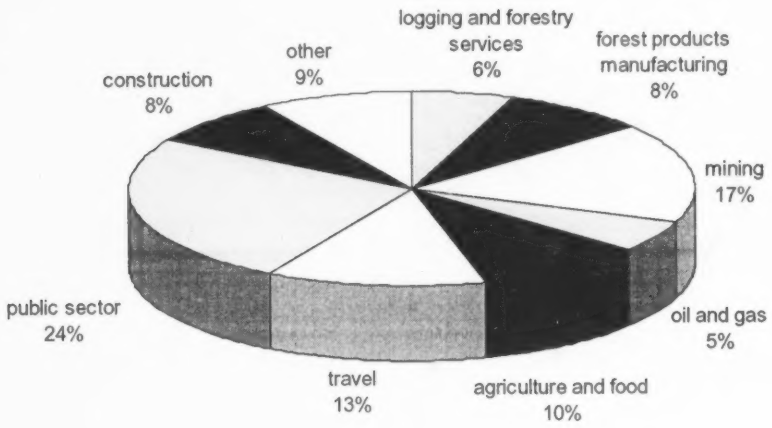


Figure 30. Dawson Creek TSA experienced labour force by sector, 1996.

Source: B.C. Ministry of Finance and Corporate Relations. 1999. The 1996 Forest District Tables.

(4) Ministry of Finance. 1999. *British Columbia Local Area Economic Dependencies and Impact Ratios – 1996.* Victoria, B.C. Ministry of Finance and Corporate Relations.

7 Socio-Economic Analysis

In 1996, the public sector was the leading employer in the district supporting approximately 24% of the labour force (see Figure 30). The forest sector, comprised of logging, forestry services, and processing, was the second largest employer supporting approximately 14% of the direct and indirect labour force. This is followed by business travel and tourism-related employment which supported approximately 13% of the labour force in accommodation and other service businesses. The agriculture and food sector accounted for 9% of the labour force. The district has experienced significant declines in the mining sector, which in 1996 supported about 17% of the workforce. These changes will affect the forest district's dependency figures.

In 2001, the Northeast Development Region, which includes the Dawson Creek, as well as the Fort Nelson and Fort St. John Forest Districts, had the lowest unemployment rate of all development regions in the province: 5.6% *versus* the provincial average of 7.7%. While low, the rate is an average that may not reflect the current situation in any particular area, and specific communities may experience higher or lower rates.

The mining sector relies on the coal industry and production in mines located near Tumbler Ridge. The closure of the Quintette coal mine and expected closure of the Bullmoose coal mine in 2003 will reduce the contribution of mining to the district's economy to a much smaller percentage. The effect of the Quintette closure is evident in Tumbler Ridge's population decline of 51% between 1996 and 2001.

Forest products processing in the forest district is dominated by lumber mills operated by Canadian Forest Products and West Fraser Mills, both of which are located in Chetwynd, and Louisiana Pacific's pulp mill in Chetwynd and Oriented Strandboard (OSB) mill in Dawson Creek.

The indirect and induced employment figures included in Figure 30 reflect the income spent by companies and employees, and the number of jobs that depend on those expenditures. Employment multipliers illustrate this spending effect: a larger multiplier indicates that each job within a particular sector will support more business activities for supply and service companies, due to higher company revenues, supply requirements and wages. For example, estimates by the Ministry of Finance indicate that every 100 full-time direct forestry jobs in the Dawson Creek Forest District support an additional 48 to 94 full-time indirect and induced jobs*, depending on the forestry activity (harvesting or processing). In comparison, every 100 full-time direct jobs in the mining industry support about 83 additional jobs, the tourism and business travel sector supports an estimated 18 indirect and induced jobs, and every 100 jobs in the public sector support an additional 28 indirect and induced jobs. The differences are due to larger spending patterns by forestry sector businesses and their employees, which tend to have higher revenues and incomes. The multipliers indicate how a change to a particular sector could affect the broader economy. Table 8 compares employment multipliers for sectors of the Dawson Creek Forest District economy.

Indirect and induced jobs
Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.

7 Socio-Economic Analysis

Table 8. Employment multipliers, by sector Dawson Creek Forest District, 1996

Basic sector*	Employment multiplier
Forestry: logging and manufacturing	1.48 – 1.94
Agriculture and food	1.26
Travel and tourism	1.18
Public sector	1.28
Mining	1.83
Construction	1.47

7.2 Dawson Creek TSA forest industry

7.2.1 Current allowable annual cut

The current (effective December 30, 1996) allowable annual cut (AAC) for the Dawson Creek TSA is 1 733 033 cubic metres, partitioned* into 846 533 cubic metres of coniferous-leading stands and 886 500 cubic metres of deciduous-leading stands. Table 9 provides a breakdown of the AAC by tenure type. Prior to the current level, the AAC was 1 841 864 million cubic metres.

Basic sector
Sectors of the economy, such as forestry, tourism and mining, that create flows of income into the region and are assumed to be drivers of the local economy. Non-basic sectors, such as retail outlets, are supported by basic sectors.

Partition
A portion of the AAC that is attributable to certain types of timber and/or terrain.

Table 9. Dawson Creek TSA apportionment of allowable annual cut, by licence type

	Coniferous (cubic metres)	Deciduous (cubic metres)	Total (cubic metres)	Per cent (%) of total AAC
Forest licences — replaceable	496 613		496 613	28.6
Forest licences — non-replaceable	100 000	600 000	700 000	40.4
Timber sale licence	72		72	0.0
Pulpwood agreements		195 169	195 169	11.3
Small Business Forest Enterprise Program (SBFEP)	220 140	81 000	301 140	17.4
Forest Service Reserve	15 498		15 498	0.9
Woodlot licences* (unallocated)	14 210	10 331	24 541	1.4
Total	846 533	886 500	1 733 033	100.0

Source: Ministry of Forests.

Woodlot licence
An agreement entered into under the Forest Act. *It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.*

7.2.2 Dawson Creek TSA harvest history

Table 10 summarizes the volume of timber harvested in the Dawson Creek TSA from 1994 to 2001. The actual volume of timber harvested is an important indicator of forestry activity in the TSA. While the AAC is the maximum allowable annual harvest level, the actual volume of timber harvested in a particular year determines the level of economic activity. Differences in annual harvest levels may be the result of cut-control[5] provisions that allow licensees to vary their annual harvest levels based on operating and market conditions. If actual annual harvest levels are consistently less than the AAC, then forestry activity is below its full potential.[6]

In 2001, approximately 1.1 million cubic metres was harvested from the Dawson Creek TSA, of which about 62% was coniferous. From 1998 to 2001, about 79% of the coniferous AAC was harvested, and 42% of the deciduous AAC was harvested.

Table 10. Dawson Creek TSA volumes billed, by licence type, 1994 to 2001

	Cubic metres (m^3)							
Tenure	**1994**	**1995**	**1996**	**1997[a]**	**1998**	**1999**	**2000**	**2001**
Forest Licence (FL)	300 860	456 873	662 438	682 563	529 441	387 202	507 403	797 116
Small Business Forest Enterprise Program (SBFEP)[b]	355 379	349 316	312 085	355 595	302 047	520 269	522 635	267 717
Timber sale licence (TSL)	0	348	31	0	0	0	0	0
Other[c]	28 942	36 333	61 064	92 175	104 020	124 997	65 721	48 217
Total	685 181	842 869	1 035 618	1 130 333	935 508	1 032 467	1 095 759	1 113 050
AAC	1 841 864	1 841 864	1 841 864	1 733 033	1 733 033	1 733 033	1 733 033	1 733 033
Average harvest 1994–2001:	983 848							
Average harvest — current cut control 1998–2001:	1 044 196							

(a) The AAC was reduced effective December 30, 1996 (as per chief forester's rationale, TSR I).

(b) Small Business Forest Enterprise Program, now replaced by the BC Timber Sales Program.

(c) "Other" consists of cutting permits such as rights-of-way, road permits, and other small temporary permits.

Source: Ministry of Forests, Economics and Trade Branch.

(5) Cut control allows licensees to vary the volume between annual harvest and AAC by +/– 50 % per year, and by +/– 10 % over a 5-year cut-control period.

(6) Full potential referred to here is based on the allocated volumes of the AAC, and is not necessarily the same as full economic potential which is based on the international market for wood products.

7.2.3 Dawson Creek TSA major licensees and processing facilities

Canadian Forest Products Ltd.

Canadian Forest Products Ltd. (Canfor) has a replaceable forest licence in the Dawson Creek TSA to harvest 87 046 cubic metres of timber per year. In 2001, Canfor harvested 92 264 cubic metres. Table 11 outlines Canfor's recent harvest activity and 1998-2000 average employment levels associated with its Dawson Creek TSA operations.

Table 11. Canfor volumes billed and provincial employment statistics

Licence allowable annual cut (AAC)	87 046 cubic metres
2001 volume billed	92 264 cubic metres
1998 – 2000 average annual volumes billed	110 423 cubic metres
Employment[a] (1998-2000 person-years)	
Harvesting, administration and silviculture	27
Processing	45
Total	72

(a) The employment figures relate only to the 1998-2000 average volume of 110 423 cubic metres harvested from the Dawson Creek TSA and processed in B.C.

Canfor operates 11 lumber mills in the province, a veneer and plywood mill, four pulp mills, two paper mills and two chip mills. One of Canfor's lumber mills is located in the Dawson Creek TSA, at Chetwynd. In 2001, this mill produced about 123 million board feet of lumber. The majority of the timber processed at Canfor's Dawson Creek mill comes from the Dawson Creek TSA and Tree Farm Licence 48.

7 Socio-Economic Analysis

West Fraser Mills Ltd.

West Fraser Mills Ltd. (West Fraser) has a replaceable forest licence in the Dawson Creek TSA to harvest 409 567 cubic metres of timber per year.

In 2001, West Fraser harvested 387 299 cubic metres. Table 12 outlines West Fraser's recent harvest activity and 1998-2000 average employment levels associated with its Dawson Creek TSA operations.

Table 12. West Fraser volumes billed and provincial employment statistics

Licence allowable annual cut (AAC)	409 567 cubic metres
2001 volume billed	387 299 cubic metres
1998 – 2000 average annual volumes billed	398 319 cubic metres
Employment[a] (1998-2000 person-years)	
Harvesting, administration and silviculture	75
Processing	163
Total	238

(a) The employment figures relate only to the 1998-2000 average volume of 398 319 cubic metres harvested from the Dawson Creek TSA and processed in B.C.

West Fraser operates seven lumber mills in the province, one medium density fibreboard (MDF) plant, one pulp and paper mill, and four chip mills. One of West Fraser's lumber mills is located in the Dawson Creek TSA. In 2001, the lumber mill produced about 205 million board feet of lumber.

Approximately 79% of the timber processed at West Fraser's Chetwynd mill was harvested in the Dawson Creek TSA, with the remainder coming from private sources and Alberta. Residual chips are processed at mills in Prince George and Mackenzie.

7 Socio-Economic Analysis

Louisiana Pacific Canada Ltd.

Louisiana Pacific Canada Ltd. (LP) has a non-replaceable forest licence in the Dawson Creek TSA to harvest 600 000 cubic metres per year from deciduous-leading stands and two pulpwood agreements* to harvest a further 195 169 cubic metres from deciduous-leading stands. In 2001, LP harvested 367 272 cubic metres. Table 13 outlines LP's recent harvest activity and 1998-2000 average employment levels associated with its Dawson Creek TSA operations. The majority of the timber was harvested under the pulpwood agreements; however, as LP begins to harvest more volume from its non-replaceable forest licence, the pulpwood agreements will no longer serve as the primary source of timber for LP's Dawson Creek mills. As both of LP's plants consume more that the forest licence provides, LP will continue to use the pulpwood agreements as a source of fibre for its mills. LP needs to procure wood from other sources (e.g., Timber Sales Program) including deciduous trees from leading-coniferous stands prior to exercising rights under the pulpwood agreements.

Table 13. LP volumes billed and provincial employment statistics

Licence allowable annual cut (AAC)	795 169 cubic metres
2001 volume billed	367 272 cubic metres
1998 – 2000 average annual volumes billed	231 000 cubic metres
Employment[a] (1998-2000 person-years)	
Harvesting, administration and silviculture	55
Processing	95
Total	150

(a) The employment figures relate only to the 1998-2000 average volume of 231 000 cubic metres harvested from the Dawson Creek TSA and processed in B.C.

In British Columbia, LP operates a lumber mill, a veneer and plywood mill, a bleached-chemi-thermo-mechanical (BCTM) pulp mill, a chip mill, an oriented strandboard (OSB) mill (see comment below regarding sale of pulp mill), and a laminated veneer lumber (LVL) mill. The pulp mill and OSB plant are located in the Dawson Creek Forest District at Chetwynd and Dawson Creek, respectively. The pulp mill has the capacity to produce about 160 000 metric tonnes per year of pulp, although it has not operated consistently or near capacity for the past five years. Tembec Inc. purchased this BCTM pulp mill from LP and expects to increase production over the next several months.

The OSB plant has the capacity to produce about 350-400 million square feet (3/8th inch basis) of OSB panels. On average about 80% of the volume processed at the two LP Dawson Creek mills comes from the Dawson Creek TSA, with the remainder mainly coming from the Fort St. John Forest District, private sources and Alberta.

Pulpwood agreements
An agreement applying to a fixed geographic area that allows harvesting of timber below sawlog standards if mill residues suitable for the facility under the agreement are not available.

Other licensees and processing facilities

The remainder of the Dawson Creek TSA timber supply has been harvested under the Small Business Forest Enterprise Program[7] which has a total AAC of 301 140 cubic metres and one minor timber sale licence for 72 cubic metres. Other sources of timber within the forest district include Canfor's TFL 48, woodlots, private lands and Indian Reserves. From 1999 to 2001, the average volume harvested under the SBFEP was 265 782 cubic metres per year. Award of a small pine licence for 100 000 cubic metres is currently underway and harvesting under this licence is expected soon.

In addition to the mills discussed above, one log home mill and three small custom sawmills operate for part of the year. Combined, the operations employ about ten individuals.

7.2.4 Forestry sector employment and employment coefficients

The preceding harvesting and employment information is used to develop employment coefficients, which are used to project future employment levels in the forestry sector. For this purpose, the forestry sector has been divided into three sub-sectors:

- harvesting and other woodlands-related employment including falling, log salvage, log scaling, log transport, harvest planning and administration;
- silviculture employment such as planting, surveying and other basic and intensive silviculture activities, such as spacing, fertilization and pruning*; and
- primary timber processing employment at lumber mills, veneer and plywood mills, shake and shingle mills, chip mills, log home mills and pulp and paper mills.

> ***Pruning***
> *The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.*

(7) The Small Business Forest Enterprise Program has been replaced by the BC Timber Sales Program.

Harvesting and silviculture employment

The harvesting sub-sector of the forest industry includes both company and contract loggers and is the first sub-sector that would be affected by any potential change in the AAC. The predominant silvicultural system used in the Dawson Creek TSA is clearcutting using ground-based skidding, cable-based systems (grapple yarding) and conventional road-based systems. The active logging season generally runs from July through March, with no activity occurring from April to June. Local residents account for an average of about 70-90% of the harvesting workforce.

The silviculture sub-sector is perhaps the least tied to the current level of harvest, given that silviculture activities are ongoing for as much as 10 to 15 years following harvesting. However, planting activity generally follows within 2 to 3 years unless natural regeneration is relied on to reforest an area. Basic silviculture consists of pre- and post-harvest surveys, site preparation, planting, brushing, cone collecting and some spacing. Enhanced, or intensive silviculture includes spacing, fertilization, and pruning. In the TSA, major licensees are responsible for basic silviculture on areas harvested under their licences. The provincial government is responsible for the remaining basic and all enhanced silviculture on Crown land, which is completed by silviculture contractors.

Employment data compiled for this timber supply review indicates that from 1998 to 2000, the average TSA harvest of 1 021 245 cubic metres per year supported about 307 person-years annually of direct harvesting and silviculture employment across the province. About 80% of this workforce reside in the Dawson Creek area.

Processing employment

The majority of timber processed at local mills comes from the Dawson Creek Forest District (including TFL 48), with some timber and chips coming from adjacent forest districts. The Dawson Creek TSA (excluding TFL 48 and private lands) accounts for an average of approximately 50% of the timber requirement for local TSA mills.

Employment data compiled for this timber supply review indicates that from 1998 to 2000, the TSA harvest of 1 021 245 cubic metres per year supported approximately 419 person-years of direct processing employment across the province. About 78% of this processing employment is associated with operations in the Dawson Creek TSA.

Forest Service employment

The Dawson Creek Forest District office located in Dawson Creek administers the TSA. Currently, about 50 people work in the forest district office. Forest Service staff are involved in administration, enforcement of government policy, and SBFEP-related planning for the Dawson Creek TSA, and management of TFL 48.

Dawson Creek TSA employment coefficients

Table 14 summarizes the employment supported by the 1998-2000 average harvest in the Dawson Creek TSA and the corresponding employment coefficients. These coefficients have been calculated for the TSA and province to highlight the level of forestry activity within the Dawson Creek TSA and to identify the contribution that the Dawson Creek TSA's forestry sector makes to the provincial economy. The two employment levels are defined as follows:

- TSA employment and employment coefficients are comprised of residents of the Dawson Creek TSA employed in the forestry sector within the TSA, and who rely on the timber supply within the TSA; and
- Provincial employment and employment coefficients are comprised of all forestry sector employment in the province that relies on the Dawson Creek TSA timber supply, including both residents of the Dawson Creek TSA and those who live elsewhere in the province.

Employment is divided into direct, indirect and induced components; the sum of the components is the total impact. The coefficients are expressed as the number of full-time jobs, or person-years, per 1000 cubic metres of timber harvested. Indirect and induced employment figures were derived using employment multipliers developed by the Ministry of Finance.

More detailed information regarding employment coefficients and multipliers is presented in Appendix B, "Socio-Economic Analysis Background Information."

Table 14. Dawson Creek TSA employment and employment coefficients[8], average 1998-2000

Forest industry activity	TSA employment (person-years)	TSA coefficients (person-years/ '000s m³)	Provincial employment (person-years)	Provincial coefficients (person-years/ '000s m³)
Harvesting	214	0.21	225	0.22
Silviculture	31	0.03	82	0.08
Processing	327	0.32	419	0.41
Total direct	572	0.56	726	0.71
Indirect + induced	296	0.29	929	0.91
Total employment	868	0.85	1,655	1.62

Note: Employment estimates are reported in person-years based on average 1998-2000 employment levels and the average 1998-2000 Dawson Creek TSA harvest of 1 021 245 cubic metres per year.

7.2.5 Dawson Creek TSA employment income

From 1998 to 2000, the average income for forestry sector employees associated with the Dawson Creek TSA was $47,140, based on average provincial income levels for logging and forestry services, solid wood manufacturing and pulp and paper manufacturing (see Appendix B). Average income for indirect and induced sector employees was $30,800. The total direct income associated with the forestry sector in the Dawson Creek TSA averaged $34.2 million per year and total income for indirect and induced employment averaged $28.6 million per year (incomes are reported in 1999 dollar values). Combined, total employment income in the Dawson Creek TSA averaged $62.8 million per year. Table 15 shows income levels, average wages and salaries, and total income per 1000 cubic metres of harvested timber.

Table 15. Average direct and indirect and induced incomes and total employment income, 1998–2000[a]

	Average wage ($)	Total income ($ millions)	Total income ($/'000s m³)
Direct	47,140	34.2	33,512
Indirect + induced	30,800	28.6	28,018
Total income		62.8	61,530

(a) All figures are in constant 1999 dollars, i.e., adjusted for inflation. Average annual harvest for the period was 1 021 245 cubic metres.

Source: Statistics Canada. Annual estimates of employment, earnings and hours. Catalogue # 10-3009XKB
Statistics Canada. Labour Force Survey, Average weekly wage rate.

(8) Other employment coefficients may be found in other documents for the same or similar areas. A difference in ratios can occur for several reasons, such as using different sources of employment data and rounding of estimates, dividing employment by a different harvest level, using a different definition of a full-time position and changing the definition of forestry sub-sectors. However, within reason the relative size of impacts associated with a change in timber supply should be similar with different coefficients.

7 Socio-Economic Analysis

7.2.6 Provincial government revenues

The provincial government receives various taxes and other revenues from the forest industry. The forest industry pays stumpage, royalties and rents to the provincial government for the rights to timber and its use, and other industry operating taxes such as corporate income, property, and sales taxes. The provincial and federal governments also receive revenues from forestry employees directly through income taxes.

From 1998 to 2000, forest industry activity in the Dawson Creek TSA provided an average of about $17.6 million in annual stumpage payments to the provincial government. Other government revenues from forest industry taxes accounted for $9.2 million per year. From 1998 to 2000, total employment supported by the Dawson Creek TSA harvest generated total annual provincial and federal income taxes worth about $15.2 million. About one-third of the total income tax, or $5.0 million per year goes to the provincial government. Table 16 shows average annual provincial government revenues for 1998-2000.

Table 16. Average annual provincial government revenues, 1998–2000[a]

	Average annual revenue ($ millions)	Average revenue ($/'000s m^3)
Stumpage (1999-2001)[b]	17.6	16,317
Industry taxes (1998-2000)	9.2	9,050
Provincial income tax (1998-2000)	5.0	4,912
Total average provincial government revenues	31.8	30,279

(a) All figures are in constant 1999 dollars, i.e., adjusted for inflation.

(b) The most recent data for stumpage were used, rather the 1998-2000 values. The 1999-2001 stumpage was divided by the 1999-2001 average harvest of 1 080 425 cubic metres per year. For industry and income taxes, 1998-2000 figures were the latest available; the taxes were divided by the 1998-2000 average harvest of 1 021 245 cubic metres per year.

Sources: Ministry of Forests, Revenue Branch; PricewaterhouseCoopers; Revenue Canada.

7 Socio-Economic Analysis

7.3 Socio-economic implications of the base case harvest forecast

The socio-economic analysis focuses on harvest level changes in the short- to mid-term (10 to 30 years from now) and considers:

- the implications of alternative harvest levels for employment and income in both the Dawson Creek TSA and the province;
- possible impacts on communities within the TSA;
- timber requirements of processing facilities within the Dawson Creek TSA; and
- regional timber supply implications.

The socio-economic analysis considers average levels of forest industry related activity that the base case forecast could support. Impacts associated with future projected harvest levels are calculated using employment, income and revenue coefficients (per 1000 cubic metres). This method assumes that the current role of the forest industry in the provincial economy and labour productivity will not change. For example, employment levels in the future can be predicted based on today's relationship between employment and the volume of timber harvested and processed. The analysis also assumes that the proportions of harvesting, silviculture and timber processing employment will remain constant and that the types and proportions of wood products manufactured will remain the same.

While this method is reasonably accurate for short-term forecasts (within the next five years), employment coefficients 20 years from now may differ due to changes in market conditions, timber processing technologies, etc. The analysis indicates the magnitude of impacts to employment, employment income and provincial government revenues, within a constantly changing socio-economic environment.

7.3.1 Short- and long-term implications of alternative harvest levels

Employment and income impacts in the Dawson Creek TSA

Dawson Creek TSA employment and income impacts focus on those workers who are supported by the TSA harvest and who reside within the TSA. Workers who come to the TSA to work but who reside outside the TSA are included in the provincial impact section, as are those supported by Dawson Creek TSA timber processed at mills located outside the TSA. Table 17 shows the employment and income that the current AAC and base case forecast could support if the timber is fully harvested and processed.

From 1999 to 2001 the average harvest in the Dawson Creek TSA was 1 080 425 cubic metres per year, 62% of the AAC.[9] This harvest level supported about 605 person-years of direct employment and a further 313 person-years of indirect and induced employment in the TSA.

The current AAC of 1 733 033 cubic metres, if fully harvested, can support about 970 person-years of direct employment and a further 503 person-years of indirect and induced employment within the TSA. This level of employment would generate about $61 million in annual total employment income.

The projected harvest level of 2 078 000 cubic metres per year indicated in the base case forecast could increase employment supported by the forest sector to 1,163 person-years of direct employment and 603 person-years of indirect and induced employment. This assessment assumes that a similar ratio of TSA to non-TSA employment will continue, which assumes additional milling capacity in the TSA.

Given the long-term stability of the timber supply as indicated by the timber supply analysis, it is likely that employment associated with the Dawson Creek TSA could either remain near its current level, or increase to meet market opportunities.

(9) This assessment uses the employment coefficients from Table 14 and applies them to the 1999-2001 average harvest to provide a more current estimate of employment. Examining a longer period of five-years would not change the analysis. The five-year (1997-2001) average harvest was 1 061 423 cubic metres *versus* the three-year (1999-2001) average harvest of 1 080 425 cubic metres.

7 Socio-Economic Analysis

Provincial employment and income impacts

Provincial employment and income impacts include all the activities supported by the Dawson Creek TSA harvest, regardless of processing location and place of residence.

From 1999 to 2001, the harvest supported an average of about 767 direct, and 983 indirect and induced person-years of employment across the province. Fully harvesting the AAC of 1 733 033 cubic metres would support about 1,230 person-years of direct employment, and a further 1,577 person-years of indirect and induced employment across the province. This level of employment results in about $106 million in annual total provincial employment income.

The projected timber supply of 2 078 000 cubic metres could support about 1,475 person-years of direct employment. Attaining this level of harvesting and processing, however, may be more dependent on market demand, than on the available timber supply.

As with the TSA assessment, given the long-term stability of the timber supply, employment levels could likely remain the same, or increase within the range presented in Table 17.

Table 17. Dawson Creek TSA socio-economic impacts: base case harvest forecast

	Current harvest rate	Current AAC	Projected timber supply Decades 1-5
Timber supply	1 733 033	**1 733 033**	**2 078 000**
Harvest level (1999-2001 average)	**1 080 425**		
Difference from current AAC	(652 608)		344 967
Dawson Creek TSA			
Employment		**(person-years)**	
Direct	605	970	1,163
Indirect + induced	313	503	603
Total	918	1,473	1,766
Range of employment gain (loss) from current harvest level		495 – 555	755 – 848
Employment income		**($1999 million per year)**	
Direct	28.5	45.7	54.8
Indirect + induced	9.7	15.5	18.6
Total	38.2	61.2	73.4
Province[a]			
Employment		**(person-years)**	
Direct	767	1,230	1,475
Indirect + induced	983	1,577	1,891
Total	1,750	2,807	3,366
Range of employment gain (loss) from current harvest level		890 – 1,057	1,360 – 1,616
Employment income		**($1999 million per year)**	
Direct	36.2	58.0	69.5
Indirect + induced	30.3	48.6	58.2
Total	66.5	106.6	127.7
Provincial government revenues		**($1999 million per year)**	
Stumpage and related payments	17.6	28.3	33.9
Forest industry taxes	9.8	15.7	18.8
Employee income taxes	5.3	8.5	10.2
Total	32.7	52.5	62.9

[a] TSA employment and income estimates are included in the provincial employment and income estimates. All estimates are derived using the information found in Tables 14, 15 and 16.

Provincial government revenue impacts

Provincial government revenues from the forest industry include stumpage, royalties and rent payments; other taxes such as logging, corporate income, sales, property and electricity taxes; and income taxes from direct, indirect and induced employees. Under the existing tax and stumpage regimes, the current average harvest rate provides approximately $32.7 million in government revenues. A harvest rate of 1 733 033 cubic metres per year, if fully harvested, would provide on average about $52.5 million annually to the provincial government, while increasing the harvest to the projected base case level could increase government revenues to $62.9 million per year.

7.3.2 Community-level impacts

The impacts related to changes in the timber supply can affect the socio-economic environment of a community. A reduction in employment and income could affect various socio-economic conditions in communities: for example, population growth rates, the size of the labour force, economic development opportunities and government-funded services. These changes would have a greater effect on an economy that is dependent on a single industry compared to one that is more diversified and experiencing growth in other sectors.

The type of changes outlined in the previous paragraph are well illustrated by the recent events in Tumbler Ridge where reductions in mining activity have led to over half of its residents migrating to other communities or provinces. However, Tumbler Ridge is not the only community in the Dawson Creek Forest District to have experienced population reductions, which overall lost 10% of its population between 1996 and 2001. The recent sale of LP's pulp mill to Tembec and the development of a new hotel may be indicators that the regional economy is improving. Given the stable timber supply forecast for the Dawson Creek TSA, the forest dependent communities in the TSA should continue to benefit from and rely on forestry for a substantial portion of the income flowing into the region.

7.3.3 Nature, production capabilities and timber requirements of processing facilities

The Dawson Creek TSA has two large lumber mills, three small lumber mills, a log home mill, a pulp mill and an OSB plant. In 2001, these mills processed approximately 1.7 million cubic metres of timber. The timber supply for these mills comes from the Dawson Creek TSA, Canfor's TFL 48, and other nearby forest districts, private sources, and Alberta. Two of the four larger mills in the Dawson Creek TSA have recently operated at least 25% below capacity. While this analysis does not examine the quality or merchantability of the timber in the TSA, or market forces that can affect operation levels, the volume available indicates that there is sufficient timber for the mills to operate at or near capacity.

7.3.4 Regional timber supply issues

The regional timber supply is an important consideration when examining potential future impacts associated with timber supply changes. The Prince George Forest Region[10] supplies timber to mills throughout the northern half of the province.

Timber supply forecasts indicate that over the next 25 years the average annual harvest in the Prince George Forest Region should remain relatively constant around 19 to 20 million cubic metres.[11] The Prince George Forest Region has the most stable timber supply forecasts in the province.

(10) The Prince George and the Prince Rupert Forest Regions are in the process of being combined into the Northern Forest Region.

(11) The current AAC for the Prince George Forest Region totals about 19.4 million cubic metres; current timber supply forecasts indicate that by approximately 2020 the timber supply in the Prince George region could be approximately 19.8 million cubic metres per year.

7 Socio-Economic Analysis

7.4 Summary

The public sector is the leading source of employment and income for local residents of the Dawson Creek TSA, followed by the forest sector, business and tourism related travel and the agriculture sector. Mining was a significant source of employment throughout the 1980s and 1990s. However, the recent closure of the Quintette coal mine and expected 2003 closure of the Bullmoose coal mine will significantly reduce the contribution of mining to the region's economy.

From 1999 to 2001, the volume of timber harvested in the Dawson Creek TSA averaged approximately one million cubic metres per year. This harvest has supported about 767 direct person-years of employment and a further 983 person-years of indirect and induced employment. Residents of the TSA account for about 53% of this total employment.

The current AAC of 1 733 033 cubic metres, if fully harvested and processed, can support about 1,230 person-years of direct forestry employment and a further 1,577 person-years of indirect and induced employment across the province. The employment income associated with this direct, indirect and induced employment would be about $106.6 million per year.

Based on the average 1999–2001 harvest, the provincial government currently collects about $32.7 million per year in stumpage and related payments, other industry taxes and provincial income taxes. Increasing harvest and processing activities to use the current AAC would result in government revenues of about $52.5 million per year.

Increasing the harvest rate to the base case level of 2 078 000 cubic metres per year would provide additional opportunities; however, it is uncertain if demand and processing capacity would increase to use this additional volume. Current employment and income levels can be expected to continue, given the stable timber supply indicated by the timber supply analysis and assuming continued market accessibility and demand.

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9 Glossary

Allowable annual cut (AAC)	The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.
Analysis unit	A grouping of types of forest — for example, by species, site productivity, silvicultural treatment, age, and or location — done to simplify analysis and generation of timber yield tables.
Base case harvest forecast	The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.
Basic sector	Sectors of the economy, such as forestry, tourism and mining, that create flows of income into the region and are assumed to be drivers of the local economy. Non-basic sectors, such as retail outlets, are supported by basic sectors.
Biodiversity (biological diversity)	The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
Biogeoclimatic (BEC) variant	A subdivision of a biogeoclimatic subzone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Biogeoclimatic zones	A large geographic area with broadly homogeneous climate and similar dominant tree species.
Coniferous	Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.
Coarse woody debris	Logs and stumps that provide habitat for plants, animals and insects, and a source of nutrients for soil development.
Cutblock adjacency	The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Deciduous	Deciduous trees shed their leaves annually and commonly have broad-leaves.

9 Glossary

Early seral

Stands are defined as early seral if they are younger than 40 years of age. An exception is deciduous-dominated stands in the Boreal White and Black Spruce biogeoclimatic zone, which are defined as early seral up to 20 years of age.

Employment coefficient

The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.

Employment multiplier

An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

Environmentally sensitive areas

Areas with significant non-timber values, fragile or unstable soils, impediments to establishing a new tree crop, or high risk of avalanches.

Forest cover objectives

Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see **Cutblock adjacency and Green-up**).

Forest inventory

An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.

Forest Practices Code

Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.

Forest type

The classification or label given to a forest stand, usually based on its tree species composition. Pure spruce stands and spruce-balsam mixed stands are two examples.

Free-growing

An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.

Green-up

The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.

9 Glossary

Growing stock	The volume estimate for all standing timber at a particular time.
Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.
Higher level plans	Higher level plans establish the broader, strategic context for operational plans, providing objectives that determine the mix of forest resources to be managed in a given area.
Indirect and induced jobs	Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.
Inoperable areas	Areas defined as unavailable for harvest for terrain-related or economic reasons. Operability can change over time as a function of changing harvesting technology and economics.
Integrated resource management (IRM)	The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.
Land and Resource Management Plan (LRMP)	A strategic, multi-agency, integrated resource plan at the subregional level. It is based on the principles of enhanced public involvement, consideration of all resource values, consensus-based decision making, and resource sustainability.
Landscape-level biodiversity	The *Landscape Unit Planning Guide* provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.
Landscape unit	A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

9 Glossary

Long-term harvest level

A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.

Management assumptions

Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

Mean annual increment (MAI)

Stand volume divided by stand age. The age at which average stand growth, or MAI, reaches its maximum is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.

Minimum harvestable age

The age at which a stand of trees is expected to achieve a merchantable condition. The minimum harvestable age could be defined based on maximize average productivity (culmination of mean annual increment), minimum stand volume, or product objectives (usually related to average tree diameter).

Mixed-wood

Forests that have a mix of coniferous and deciduous trees.

Model

An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.

Modification VQO

Visible alterations may dominate the landscape, but should blend with natural features. Up to 25% of the visible area can be altered by harvesting activity.

Natural disturbance type (NDT)

An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas subject to less frequent stand-initiating disturbances usually have more older forests.

Non-merchantable forest types

Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.

9 Glossary

Not satisfactorily restocked (NSR) areas	An area not covered by a sufficient number of well-spaced trees of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.
Old seral	Old seral refers to forests with appropriate old forest characteristics. Ages vary depending on forest type and biogeoclimatic variant.
Operability	Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Partition	A portion of the AAC that is attributable to certain types of timber and/or terrain.
Person-year(s)	One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.
Preservation VQO	Alterations are generally not visible. Up to 1% of the visible landscape can be visibly changed by harvesting activity.
Protected area	A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).
Pruning	The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.
Pulpwood agreements	An agreement applying to a fixed geographic area that allows harvesting of timber below sawlog standards if mill residues suitable for the facility under the agreement are not available.
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Scenic area	Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.
Sensitivity analysis	A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or base case.

9 Glossary

Site index	A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.
Stand-level biodiversity	A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Table Interpolation Program for Stand Yields	A B.C. Forest Service computer program used to generate yield projections for managed stands based on interpolating from yield tables of a model (TASS) that simulates the growth of individual trees based on internal growth processes, crown competition, environmental factors and silvicultural practices.
Timber harvesting land base	Crown forest land within the timber supply area where timber harvesting is considered both acceptable and economically feasible, given objectives for all relevant forest values, existing timber quality, market values and applicable technology.
Timber supply	The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 7* of the *Forest Act*.
Tree farm licence (TFL)	Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.
Ungulate	A hoofed herbivore, such as deer.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) that is not harvested.
Variable Density Yield Prediction model	An empirical yield prediction system supported by the Ministry of Sustainable Resource Management, designed to predict average yields and provide forest inventory updates over large areas (i.e., Timber Supply Areas). It is intended for use in unmanaged natural stands of pure or mixed species composition.

9 Glossary

Visual quality objective (VQO)

Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.

Volume estimates (yield projections)

Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.

Wildlife tree

A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

Woodlot licence

An agreement entered into under the *Forest Act*. It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.

Appendix A

Description of Data Inputs and Assumptions for the Timber Supply Analysis

Introduction

The following tables and commentary outline the methods and inputs used to derive the timber harvesting land base, and to construct the timber supply model for the Dawson Creek TSA timber supply analysis. This information represents current forest management in the area. Current management is defined as the set of land-use decisions and forest and stand management practices currently implemented and enforced. Future forest management objectives that may be intended, but are not currently implemented and enforced are not included in this appendix.

The purpose of the timber supply review is to provide information on the effects of current management on both short- and long-term timber supply in each timber supply area in the province. Any changes in forest management objectives and practices, and any improvements to the data will be included in subsequent timber supply analyses.

A.1 Inventory Information

Table A-1. lists the inventories that were used to define the timber harvesting land base and to model forest management activities.

Table A-1. Inventory information

Data	Inventory source	Vintage	Update	Input scale
Forest cover	Ministry of Forests (MoF)	1970-1988	1999	1:20 000
Forest development plan cutblocks — non-standard overlay for FC1 update	Licensee & SBFEP FDPs	1999	—	1:20 000
Known archaeological sites	MSRM[a]	1995	1999	1:50 000
Riparian — stream classification	MSRM[a] — TRIM II	1996	—	1:20 000
Riparian — wetland classification	MoF — FC1/FIP	1970-1988	—	1:20 000
Riparian — lake classification	MoF — FC1/FIP	1970-1988	—	1:20 000
Visual landscape	MoF	1991	1996 1999/00	1:50 000
Recreation features	MoF	1992/93	1999/00	1:50 000
Grazing tenures — non-standard overlay	MoF — Atlas- / district range tenure maps	1970-1988	1998	1:20 000
Caribou management zone — non-standard overlay	MoF LRMP	1994	1998	1:250 000
Ungulate winter range (UWR) — non-standard overlay	Northeast Coal/ MSRM	1999	—	1:250 000
Grizzly bear management zone — non-standard overlay	MoF	1999	—	1:250 000
Wildlife burns — non-standard overlay	MSRM	1999	—	1:50 000
Base ownership	MoF — FC1/FIP	1970-1988	—	1:20 000
LRMP resource management zone (RMZ) boundaries	MoF LRMP	1994	1998	1:20 000 1:250 000
Goal 1 and 2 Protected Areas			1999	1:20 000
Woodlot tenure — non-standard overlay	MoF	1999	—	1:20 000
Agriculture land reserve	MAFF[a]	1990	1999	1:50,000
Draft landscape unit boundaries	MoF	1996	1999	1:20 000
Planning cell boundaries	MoF	1999	—	1:20 000
District boundary	MoF	1992	1999	1:250 000

(continued)

(a) MSRM = Ministry of Sustainable Resource Management;
MAAF = Ministry of Agriculture, Fisheries and Food;
MEM = Ministry of Energy and Mines;
GSC = Geological Survey of Canada.

A.1 Inventory Information

Table A-1. Inventory information (concluded)

Data	Inventory source	Vintage	Update	Input scale
Pulpwood agreement 7, 10, 13 boundaries	MoF LRMP	1992	1998	1:250 000
Tree farm licence (TFL) 48 boundaries	MoF	1992	1999	1:20 000
Roads, trails and landings (RTLs)	MoF — FC1/FIP MSRM TRIM II	1970-1988 1996	— 1999	1:20 000
Utilities	MoF — FC1/FIP MSRM TRIM II	1970-1988 1996	— 1999	1:20 000
Oil and gas well sites	MoF – FC1/FIP MSRM TRIM II	1970-1988 1996	— 1999	1:20 000
Biogeoclimatic ecosystem classification	MoF	1998	Ver. 1.2	1:20 000
Physical operability:				
Surficial geology 93I block	MEM[a]	1959	1999	1:50 000
Surficial geology 93P & 94A blocks	GSC[a]	1970	1999	1:250 000
Lacustrine inventory 930 & 94B blocks	MoF	1998	1999	1:250 000
Slope	MSRM — TRIM II	1996	1999	1:20 000

(a) MSRM = Ministry of Sustainable Resource Management;
MAAF = Ministry of Agriculture, Fisheries and Food;
MEM = Ministry of Energy and Mines;
GSC = Geological Survey of Canada.

Data source and comments:

Forest cover

The forest cover database was updated for timber harvesting activities occurring from 1994 to 1999 within the TSA (refer to Forest Development Plan Cutblocks). The inventory file was projected for growth to 1999.

Known archaeological sites

Known archaeological sites are represented as point features across the Dawson Creek Forest District. Data were provided in an Arc/Info coverage at 1:250 000 by MSRM, Terrestrial Information Branch (at the time of initiation of the data gathering, archaeology information was managed by the Ministry of Small Business, Tourism and Culture, Archaeology Branch), and include paleontological, prehistoric and historic features.

Forest development plan cutblocks

A non-standard cutblock inventory was generated from a compilation of major licensees' Forest Development Plans. This inventory was used to update the forest cover within the Dawson Creek Forest District to represent cutblock disturbance up to December, 1999. The coverage includes cutblocks that have been completely harvested, or cutblocks where harvesting is in progress, since the most recent forest cover update.

Riparian features

Three inventories are used to represent riparian features across the Dawson Creek Forest TSA. Streams and rivers are represented using TRIM II data at 1:20 000 while lakes and wetlands are represented using forest cover at 1:20 000. Reserve zones for each feature have been buffered according to criteria described in the *Riparian Management Area Guidebook*, and subsequently merged into one coverage to facilitate analysis.

A.1 Inventory Information

Visual landscape

The visual landscape inventory represents visual quality objectives across the Dawson Creek Forest District at 1:50 000. The updated inventory reflects revisions to visual quality objectives along the Peace River corridor where visual landscape inventories have identified visually sensitive areas. The inventory has been reformatted to Resource Inventory Committee (RIC) standards and represents known VQOs.

Recreation features

The recreation features inventory represents recreation features across the Dawson Creek Forest District at 1:50 000. The updated inventory reflects electronic reformatting of the original inventory to RIC standards.

Grazing tenures

A non-standard inventory was generated at 1:20 000 to represent Crown grazing permit areas and Crown grazing leases across the Dawson Creek Forest District. The tenure boundaries are based on forest cover and atlas information, and are current to October 1999.

Caribou management zone

Winter range for the northern ecotype caribou within the *Dawson Creek Land and Resource Management Plan* (LRMP) is represented as a non-standard inventory at 1:250 000. The caribou zone was delineated using various sources of information including Northeast Coal studies and the MSRM (Ministry of Environment, Lands and Parks at the time of data gathering) surveys information.

Ungulate winter range (UWR)

A non-standard inventory of winter range for all species of ungulate within the forest district is represented at 1:250,000. This inventory is based on various sources of information including Northeast Coal studies and MSRM surveys.

Grizzly bear management zone

The grizzly bear zone is represented within the Dawson Creek Forest District as a non-standard inventory at 1:250 000. The zone occurs within natural disturbance types (NDT) 1 and 2, in mountainous terrain along the western portion of the district. It is also referenced as habitat zone A within the Dawson Creek Forest District's Pesticide Management Plan. The inventory is based on forest cover and TRIM II data.

Wildlife burns

The non-standard wildlife burn inventory represents the MSRM's recent compilation of wildlife burn sites within the Dawson Creek Forest District, mapped at 1:50 000. The inventory is based on forest cover and TRIM II data.

Base ownership

Base ownership is represented within the Dawson Creek Forest District at 1:20 000. Ownership is based on forest cover and atlas information.

Land and resource management plan (LRMP) resource management zone boundaries

Resource management zones within the approved Dawson Creek LRMP are represented at 1:250 000. Zone boundaries are based on TRIM II water features, heights of land, and roads. Protected areas and community pastures are identified as separate resource management zones within this inventory.

Woodlots

Woodlot tenures within the Dawson Creek Forest District are represented at 1:20 000. Woodlots are usually accounted for in the ownership layer, however the ownership data for woodlots is known to be unreliable. This non-standard inventory is based on forest cover and district woodlot tenure information.

A.1 Inventory Information

Agriculture land reserve (ALR)

Agriculture land reserve within the Dawson Creek Forest District was digitized by the Agriculture Land Commission in 1990 at 1:50 000, and subsequently revised using TRIM I water features, heights of land, and roads, and cadastral data (CDMS) at 1:20 000. The inventory is current to January 31, 1999.

Draft landscape unit boundaries

Draft landscape unit boundaries within the Dawson Creek Forest District were delineated using TRIM I and TRIM II water features, heights of land, and roads, and also forest cover. Boundaries have been mapped at 1:20 000. Some draft landscape units include land within Tree Farm Licence (TFL) 48 and land not administered by the Ministry of Forests.

Planning cell boundaries

Planning cell boundaries within the Dawson Creek Forest District are based on TRIM I and TRIM II water features, heights of land, and roads, and also forest cover. Some planning cells include land within TFL 48 and land not administered by the Ministry of Forests.

Forest district boundary

The district boundary represents recent revisions based on the Watershed Atlas. This coverage is recognized as the official Dawson Creek Forest District boundary.

Pulpwood agreement boundaries

Pulpwood agreement (PA) boundaries delineate areas in two deciduous pulpwood agreements and one coniferous pulpwood agreement within the Dawson Creek Forest District. The coverage was provided by the Ministry of Forests', Resource Tenures and Engineering Branch, and is mapped at 1:250 000.

TFL 48 boundaries

TFL 48 comprises five main TFL blocks within the Dawson Creek Forest District. The coverage was provided by the Ministry of Forests', Resource Tenures and Engineering Branch, and reflects the addition of the Rice Properties.

Roads, trails and landings (RTLs)

The roads, trails and landings inventory represents unclassified access-related disturbances at 1:20 000 within the Dawson Creek Forest District, current to December 1999. The inventory is based on forest cover and TRIM II information.

Utilities

The utilities inventory represents linear disturbances for powerlines, pipelines and railways at 1:20 000 within the Dawson Creek Forest District, current to December 1999. The inventory is based on forest cover and TRIM II information.

Oil and gas well sites

This inventory represents well sites as point features at 1:20 000 within the Dawson Creek TSA, current to December 1999. Well sites are buffered according to criteria specified in Table A–6. This inventory is based on forest cover and TRIM II information.

Biogeoclimatic ecosystem classification (BEC)

The biogeoclimatic ecosystem classification (Version 1.2) is represented to the variant level within the Dawson Creek Forest District at 1:20 000.

A.1 Inventory Information

Physical operability

Physical operability represents a compilation of terrain and slope data for the Dawson Creek Forest District. It is based on four principal data sources. For forest cover mapsheets within 93I letter block, 1959 surficial geology data from the Ministry of Energy and Mines were digitized at 1:50 000. For mapsheets within 93P and 94A letter blocks, 1970 surficial geology data from the Geological Survey of Canada were digitized at 1:250 000. For mapsheets within 93O and 94B letter blocks, 1998 aerial photo-interpreted parent material classifications from the Ministry of Forests (Prince George Regional Office) were digitized at 1:250 000. Slope data from TRIM II are represented at 1:20 000 using slope classes that reflect the current technological capabilities of harvesting systems used in the district (Table A-7., Description of physical operability).

Vegetation resources inventory

In 1997 the Ministry of Forests initiated a Vegetation Resources Inventory (VRI) project for the Dawson Creek TSA. Phase II ground sample measurements were collected during 1998-2001 and final analysis of the VRI results was completed in March 2002. Statistically-based height, age and volume adjustment factors for deciduous, spruce, pine, and subalpine fir-leading stands were developed and incorporated into the timber supply analysis. Table A–2. shows the VRI adjustments for height , age and volume employed in the analysis.

Net volume adjustment factors (NVAFs), based on destructive sampling for decay, were also derived and are included in Table A-2. The NVAFs were not employed in the base case of the timber supply analysis due to related uncertainties when the analysis was initiated. Adjustment factors for volume were based on existing loss factors. Additional analysis showed that if the volume adjustments had been based on NVAFs the increase in timber supply relative to the base case would be approximately 5% over the 250 year forecast horizon. This information will be presented to the chief forester for consideration during the AAC determination.

Reports documenting the derivation of height, age and volume *adjustments (Dawson Creek TSA — Documentation of VRI Final Analysis*: May 14, 2002, and *Dawson Creek TSA — Documentation of Vegetation Resources Inventory Interim Analysis*) can be found on the Ministry of Sustainable Resource Management website at:

http://srmwww.gov.bc.ca/tib/reports/invadjreports/invadjreports.htm.

A.1 Inventory Information

Table A-2. Vegetation resources inventory adjustment ratios used in the timber supply analysis — Dawson Creek TSA, 2002

Stratum	Sub-category	Compiler utilization (cm)	Inventory age range (years)	Age adjustment ratio	Height adjustment ratio	Loss factor volume adjustment ratio	NVAF[a] volume adjustment ratio
Bl		17.5	All ages	0.940	0.981	1.110	1.320
At, Ac		12.5	<=80	1.236	1.151	1.417	1.487
		12.5	>80	0.855	0.951	1.345	1.479
Sw		17.5	All ages	0.804	1.024	1.002	1.103
Pl (no stkcl 4)	Pine	12.5	Age_prj<=60	0.934	1.155	0.617	0.617
		12.5	60<age_prj<= 120	0.991	0.948	1.340	1.426
		12.5	Age_prj>120	0.887	0.827	1.019	1.110
	Small pine	9.0	60<age_prj<= 120	0.991	0.948	1.472	1.567
		9.0	Age_prj>120	0.887	0.827	1.198	1.300
Sb, L, Pl (s/c4)		17.5/17.5/12.5	All ages	0.899	0.957	1.956	2.032

(a) NVAF — net volume adjustment factor.

A.2 Zone and Analysis Unit Definitions

A.2.1 Management zones

Management zones represent areas with distinct management emphasis. For example, a zone may be based on a harvesting system, silvicultural system, visual quality objective or wildlife consideration. Some areas may be subject to more than one management objective. Grouping enables the analyst to apply overlapping constraints to such areas.

Table A-3. provides general descriptions of the management objectives and related information tracked in the analysis. The non–contributing forest (i.e., forested land not available for timber harvesting) is included for consideration in attaining forest cover objectives for landscape-level biodiversity and visual quality. Further information on the forest cover requirements to be applied to these areas can be found in Section A.4.11, "Forest cover requirements — integrated resource management."

Table A-3. Objectives to be tracked

Objectives	Inventory definition	Function
Landscape-level biodiversity	Standard mapped layer (FIP file); BEC inventory	Application of biodiversity targets at the landscape unit/emphasis/BEC variant level. Applied to all Crown forest.
General integrated resource management (IRM)	Operable area not subject to specific non-timber management objective	Application of adjacency criteria by landscape unit. Applied to timber harvesting land base.
Caribou management zone	Non-standard mapped layer	Forest cover requirements associated with low elevation caribou habitat applied to the caribou management zone (specifically greater than 44% of the Crown forested land base in mature + old seral classes of which at least 11% represents old seral classes).
Grizzly bear management zone	Non-standard mapped layer	Forest cover constraints associated with priority grizzly bear habitat included in the base case using the early seral retention per cent for intermediate biodiversity emphasis in natural disturbance types 1 and 2 (*Biodiversity Guidebook*).
Visual landscape objectives	Standard mapped layer (visual sensitivity classes include: preservation, retention, partial retention, modification)	TSA cutblock adjacency requirements; and provincial guidelines for factoring visual resources into timber supply analysis

Data source and comments:

See Section A.1, "Inventory information" for the sources of the management zone information referenced above.

A.2 Zone and Analysis Unit Definitions

A.2.2 Analysis unit characteristics

An analysis unit represents forest stands with similar tree species (as indicated by the inventory type group), similar timber growing capability (as indicated by the site index in the forest inventory file) and similar forest management regimes. Table A-4. lists the analysis units and their description. The amount of timber harvesting land base in each analysis unit is shown in Table A-15., "Dawson Creek TSA minimum harvestable ages."

Each analysis unit was assigned its own timber volume projection or yield table. Yield tables for existing natural stands and regenerating deciduous stands were derived using the variable density yield prediction (VDYP) yield model. Yield tables for recent plantations and future coniferous stands were derived using the table interpolation program for stand yields (TIPSY), batch version.

Table A-4. Dawson Creek TSA analysis units and regenerated stand species

Primary analysis unit	Existing stand description	Site class	Site index range	Existing unmanaged analysis units[b]		Existing managed analysis units[b]	Future regenerating analysis unit[b]	Regenerating stand description
				Thrifty stands (13-140 years)	Old stands (>140 years)			
1	Spruce — pure	G	>20.5	0111	—	—	0114	Spruce
		M	13.5-20.5	0121	0122	0124	0124	
		P	<13.5	0131	0132	-	0134	
2	Balsam — pure	M	>13.5	—	—	0224	0224	Spruce-balsam
		P	<13.5	0231	0232	—	0234	
3	Pine — pure	G	>18.5	0311	—	—	0314	Pine
		M	12.5-18.5	0321	—	0324	0324	
		P	<12.5	0331	—	—	0334	
4	Small pine[a] — pure	M	All	0421	0422	—	0424	Small pine
5	Aspen — pure	G	>20.5	0511	—	—	0514	Aspen
		M	15.5-20.5	0521	—	—	0524	
		P	<15.5	0531	—	—	0534	
6	Balsam poplar — pure	G	>20.5	0611	—	—	0614	Balsam poplar
		M	16.5-20.5	0621	—	—	0624	
		P	<16.5	0631	—	—	0634	
7	Spruce — leading	G	>20.5	0711	—	—	0114	Spruce
		M	13.5-20.5	0721	0722	0124	0124	
		P	<13.5	0731	0732	—	0134	
8	Pine — leading	G	>18.5	0811	—	—	0314	Pine
		M	12.5-18.5	0821	0822	0324	0324	
		P	<12.5	0831	—	—	0334	
9	Small pine[a] —leading	M	All	0921	0922	—	0424	Small pine
10	Balsam — leading	M	>13.5	1021	—	0224	0224	Spruce-balsam
		P	<13.5	1031	1032	—	0234	
12	Aspen — leading	G	>20.5	1211	—	—	0514	Aspen
		M	15.5-20.5	1221	—	—	0524	
		P	<15.5	1231	—	—	0534	

(a) Small pine stands defined as pine-leading stands where age > 80 years and 17.5 m ≤ height < 19.5 m.

(b) Analysis unit legend:
1st and 2nd digit = primary analysis unit (spruce=1,7; balsam=2, 10; pine=3,4,8,9; aspen=5, 12 ,55 ,56; balsam poplar=6, 13, mixed-wood = 15-20);
2nd digit = relative productivity rating (G=1; M=2; P=3);
3rd digit = stand class (thrifty = 1; old = 2; existing and future managed=4).

(continued)

A.2 Zone and Analysis Unit Definitions

Table A-4. Dawson Creek TSA analysis units and regenerated stand species (concluded)

Primary analysis unit	Existing stand description	Site class	Site index range	Existing unmanaged analysis units[a]		Existing managed analysis units[b]	Future regenerating analysis unit[b]	Regenerating stand description
				Thrifty stands (13-140 years)	Old stands (>140 years)			
13	Balsam poplar leading	G	>20.5	1311	—	—	0614	Balsam poplar
		M	15.5-20.5	1321	—	—	0624	
		P	<15.5	1331	—	—	0634	
15	Spruce — mix	G	>21.5	1511	—	—	1514	Spruce-aspen
		M	16.5-21.5	1521	—	1524	1524	
		P	<16.5	1531	—	—	1534	
16	Pine — mix	G	>18.5	1611	—	—	1614	Pine-aspen
		M	13.5-18.5	1621	—	1624	1624	
		P	<13.5	1631	—	—	1634	
17	Conifer — mix	G	>19.5	1711	—	—	1714	Spruce-pine aspen
		M	14.5-19.5	1721	—	1724	1724	
		P	<14.5	1731	—	—	1734	
18	Aspen — mix	G	>19.5	1811	—	—	1814	Aspen-spruce
		M	14.5-19.5	1821	—	—	1824	
		P	<14.5	1831	—	—	1834	
19	Balsam poplar — mix	M	All	1921	—	—	1924	Balsam poplar-spruce
20	Deciduous — mix	G	>20.5	2011	—	—	2014	Aspen-balsam poplar-spruce
		M	14.5-20.5	2021	—	2024	2024	
		P	<14.5	2031	—	—	2034	
55	Aspen — pure	G	>20.5	5511	—	—	5514	Aspen (grazing areas)
		M	15.5-20.5	5521	—	—	5524	
		P	<15.5	5531	—	-	5534	
56	Aspen — leading	G	>20.5	5611	—	—	5514	Aspen (grazing areas)
		M	15.5-20.5	5621	—	—	5524	
		P	<15.5	5631	—	—	5534	

(a) Small pine stands defined as those pine-leading stands where age > 80 years and 17.5 m < height < 19.5 m.

(b) Analysis unit legend:
1st and 2nd digit = primary analysis unit (spruce=1,7; balsam=2, 10; pine=3,4,8,9; aspen=5, 12 ,55 ,56; balsam poplar=6, 13, mixed-wood = 15-20);
2nd digit = relative productivity rating (G=1; M=2; P=3);
3rd digit = stand class (thrifty = 1; old = 2; existing and future managed=4).

A.3 Definition of the Timber Harvesting Land Base

The following sections describe the criteria used to define the timber harvesting land and are placed in the order in which the reductions were applied for the analysis.

A.3.1 Land classified as non-forest or non-productive forest land

Alpine, lakes, rocks, etc., represented by inventory type identities 6 and 8 were excluded from the timber harvesting land base.

A.3.2 Woodlot licences

The total land base is stratified into various ownership codes. Ownership and character code '77N' usually identify areas in woodlot licences but this mapping is outdated. The Dawson Creek Forest District provided a separate woodlot boundary inventory through a non-standard overlay for use in the timber supply analysis.

The AAC attributable to these areas is not included in the assessment of the current AAC for the Dawson Creek TSA. At the time of the timber supply analysis the total volume allocated to woodlot licences (Schedule B) was 38 375 cubic metres per year.

A.3.3 Land not managed by the British Columbia Forest Service

Areas where the provincial government has no jurisdiction such as private, municipal, and federal land, as well as Indian Reserves, do not contribute to the Crown Forest. These areas are identified as ownership codes 40N to 54N, 61C/N and 81N. There are no Timber Licence (ownership codes 70 and 71). For the analysis, areas identified as Tree Farm Licence (ownership codes 72B and 76N) were excluded from the database used in the analysis.

A.3.4 Parks and reserves

Provincial parks, ecological reserves and recreation areas (ownership codes 60N and 62N to 69N) and new parks (identified through an additional non-standard overlay) are not managed for timber, and were therefore excluded from the timber harvesting land base, but contribute to landscape-level biodiversity objectives.

A.3.5 Total forested area managed by the British Columbia Forest Service (Crown forest)

Productive forest in ownership codes 62C (forest management unit) and 69C (forest reserves) contribute to the timber harvesting land base of the TSA. Agricultural land reserve (ALR), Crown grazing leases, and grazing permit areas contribute to the timber harvesting land base and are identified through additional non-standard overlays. Community pastures also contribute to timber supply and are delineated in the resource management zone (RMZ) inventory as enhanced-grazing reserves.

A.3.6 Non-commercial cover

Type identity code 5 represents areas currently occupied by non-commercial brush species. These areas are considered to be unlikely sites for timber production. Because no rehabilitation of these sites is planned, they are removed from the land base considered available for timber supply.

A.3.7 Riparian reserve and management zones

Table A-5. summarizes stream, wetland and lake classifications, and the corresponding widths of riparian reserve and riparian management zones for the Dawson Creek TSA. Riparian reserve and riparian management zone widths are based on those specified for each feature class in the *Riparian Management Area Guidebook*.

Table A-5. Riparian areas (streams, wetlands, and lakes)

	Riparian class	Average channel width (metres) or wetland/lake size (ha)	Reserve zone width (metres)	Management zone width (metres)	Total riparian management area (RMA) width (metres)
Streams					
	S1	≥ 100 m	0	100	100
	S1	> 20 and < 100 m	50	20	70
	S4	< 1.5 m	0	30	30
	S6	≤ 3 m	0	20	20
Wetlands					
	W1	> 1000 ha	0	0	0
	W1	> 5 ha	10	40	50
	W3	1-5 ha	0	30	30
	Unclassified	< 1 ha	0	0	0
Lakes					
	L1	> 1000 ha	0	0	0
	L1	< 1000 ha	10	0	10
	L3	1-5 ha	0	30	30

Data source and comments:

Stream classifications are based primarily on slope gradient with secondary emphasis on stream width using TRIM data. Due to difficulty in interpreting stream width, interpretations have been broadly classified into S1, S4, and S6 categories.

Wetland and lake classifications are based on feature area, and in the case of wetlands, by forest cover type. Wetlands are defined as non-productive black spruce types. Wetland classifications include W1 and W3 classes and also unclassified wetlands, while lake classifications include L1 and L3 classes.

For the timber supply analysis, the data from the features non-standard overlays were compiled as a per cent of the total stand polygon area by riparian class shown in the above table. The data were also compiled in conjunction with major road, minor road and utility corridor (described below) to prevent "double-counting" polygon area.

A.3.8 Transportation features

Separate estimates were made to reflect the loss in productive forest due to construction of existing and future roads, trails and landings (RTL). Other features include seismic lines, power and pipelines, railways, and well sites not captured in the FIP file. Existing RTL estimates are applied as reductions to the current productive forest considered available for harvesting and future RTL reductions are applied after stands are harvested for the first time in the simulation model.

Existing roads, trails, landings and other features were mapped as a non-standard geographic information system (GIS) file. The features and the associated reductions to the timber harvesting land base are shown in Table A-6.

A.3 Definition of the Timber Harvesting Land Base

Table A-6. Estimates for existing roads, trails, landings and other features

Disturbance feature	Disturbance width/area	Group type
Logging/secondary roads	20 m	Road
Access roads	15 m	Road
Secondary roads (MOT)	25 m	Road
Trails	5 m	Road
Railway	20 m	Road
Landings	0.25 ha/ landing	Road
Well sites	1.44 ha/site	Utility
Power lines	20 m	Utility
Pipe lines	18 m	Utility
Seismic lines	7 m	Utility

Data source and comments:

For the timber supply analysis, the data from the features non-standard overlay was compiled as a per cent of the total stand polygon area by group type shown in Table A-6. This required the reduction to be made early during the land base derivation (i.e., prior to any partial polygon or total/partial resultant reductions) since the initial reference was the entire polygon area).

Well sites (208 hectares) were mapped as a separate non-standard overlay, and a count of well sites by mapsheet and polygon was provided for the timber supply analysis. District staff estimate the average area of a well site to be 1.44 hectares.

To account for future RTLs, a five per cent deduction was applied after stands were harvested for the first time. All highways and larger municipal roads of a sufficient size to be mapped as polygons and classified as non-forest areas in the forest inventory file were removed from the timber harvesting land base as non-forest area. Estimates for existing and future RTLs within the Dawson Creek TSA are detailed in a report entitled, *Manual review of roads, trails, landings, seismic lines and utilities corridors in the Dawson Creek TSA* (Dawson Creek Forest District, December 1999).

A.3 Definition of the Timber Harvesting Land Base

A.3.9 Physically inoperable areas

In the Dawson Creek TSA, areas were defined as inoperable using slope classes and soil/parent material types as listed below in Table A-7. Areas classified as inoperable (operability code I) were excluded from the timber harvesting land base.

Table A-7. Description of physical operability

Operability type	Slope (%)	Parent material	Operability code
Conventional (ground)	0-30	Lacustrine	A
Conventional (ground)	0-40	Moraine	A
Cable[a]	> 30-80	Lacustrine	C
Cable[a]	> 40-100	Moraine	C
Aerial[b]	> 100	Moraine	H
Inoperable	> 80	Lacustrine	I

(a) Cable includes mixed conventional/cable harvesting systems.

(b) Aerial includes mixed aerial/cable harvesting systems.

Data source and comments:

Classification of parent materials within the Dawson Creek TSA is based on the three sources of terrain data identified earlier in Table A-1., "Inventory information," under physical operability. Earlier versions of physical operability have been updated by incorporating more detailed slope and soils information in association with current harvesting practices in the Dawson Creek TSA.

Slope classes are derived using the TRIM inventory and reflect harvest equipment capability and environmental suitability. Additionally, Workers Compensation Board slope limitations for ground-based systems have been incorporated. Soil/parent material types have been categorized according to their sensitivity to disturbance. Generally, fine-textured aeolian, alluvial/fluvial, and lacustrine parent materials are considered to be more sensitive soil types.

A.3 Definition of the Timber Harvesting Land Base

A.3.10 Problem forest types

Problem forest types (PFT) are stands that are physically operable and exceed low site criteria yet are not currently utilized or have marginal merchantability.

Table A-8. lists the problem forest types that were excluded from the timber harvesting land base.

Table A-8. Problem forest types criteria

Leading species	Inventory type group	Primary analysis unit	Stocking class	Reduction (%)
Black spruce	21-26	1, 7, 13		100
Lodgepole pine (stocking class 4)	28-31	3, 4, 8, 9, 14	4	100
Cedar, hemlock, larch, fir	1-17, 33, 34	15		100
Alder, maple, birch	37, 38, 39, 40	18		100

A.3.11 Economically inoperable areas

Dawson Creek Forest District staff conducted a detailed review of the TSA to examine planning cells with high development costs and limited merchantable timber volume. All or a proportion of these areas (summarized in Table A-9.) were excluded from the timber harvesting land base. In addition, to account for several areas that are known by district staff to be physically inaccessible for timber harvesting (i.e., hanging valleys, small isolated stands, etc.), in the analysis, a further one per cent was excluded from the timber harvesting land base (one per cent area reduction to all polygons).

Table A-9. Exclusion of specific, geographically defined areas

Planning cells	Forest exclusion (%)
102	100
201	100
202	20
214	100
301	10
403	100
501	80
1204	20
2403	50
2405	30
2409	100
2410	30

A.3 Definition of the Timber Harvesting Land Base

A.3.12 Recreation feature reductions

Recreation values across the Dawson Creek TSA are identified in a recreation feature inventory. This inventory updates and replaces ESA recreation information. Table A-10. presents the per cent area exclusions by recreation feature significance and management class found within the timber supply area.

Table A-10. Per cent area exclusions by recreation feature significance and management class

Feature significance	Recreation management class		
	0 very sensitive	1 sensitive	2 Not senstive
A. Very high	100	20	20
B. High	100	20	20
C. Moderate	100	0	0

The recreation management classes describe the sensitivity of recreation inventory polygons to disturbance:

0	Very sensitive	Outstanding recreational, educational, scientific or heritage values
1	Sensitive	Requires special management practices
2	Not sensitive	Normal forest management practices

The recreation features inventory was completed in 1992/3 using procedures described in the *Ministry of Forests Recreation Manual*. A combination of local knowledge, public input, field reconnaissance, air photo interpretation, topographic maps, and other resource agency information was researched to complete the inventory.

A.3.13 Non-merchantable forest types

Sites may have low productivity either because of inherent site factors (e.g., nutrient availability, exposure, excessive moisture), or because they are not fully occupied by commercial tree species. These stands are not considered to be harvestable, and were removed from the timber harvesting land base.

A.3 Definition of the Timber Harvesting Land Base

Table A-11. lists the harvesting systems and the associated per cent reduction for mature stands in the Dawson Creek TSA. Maturity criteria by species are provided in Table A–12.

Table A-11. Per cent area reductions for mature stands based on harvesting system and volume per hectare

Harvesting system	Per cent area reduction by stand volume class		
	< 120 m³/ha	120-200 m³/ha	> 200 m³/ha
Conventional	97	0	0
Cable[a]	100	100	0
Aerial[b]	100	100	0
All	N/A	N/A	N/A

(a) Cable includes mixed conventional/cable harvesting systems.

(b) Aerial includes mixed aerial/cable harvesting systems.

Table A-12. lists the criteria for including immature stands in the timber harvesting land base. The criteria are listed by harvesting system, leading species and associated analysis units. Small pine, aspen and balsam poplar stands are typically harvested only on sites that are operable with conventional harvesting technology. Immature small pine, aspen and balsam poplar stands on cable or aerial ground were excluded from the timber harvesting land base.

Table A-12. Inclusion criteria for immature stands by harvesting system

Harvesting system	Leading species	Primary analysis unit	Age at maturity (years)	Minimum volume at maturity age
All	Spruce	1, 7, 13, 15	120	120
All	Balsam	2, 10	120	120
All	Pine	3, 8, 14	100	120
Conventional	Small pine	4, 9	80	120
Conventional	Aspen	5, 11, 16, 18	80	120
Conventional	Balsam poplar	6, 12, 17	80	120

A.3 Definition of the Timber Harvesting Land Base

A.3.14 Sensitive wildlife habitat

Areas of sensitive wildlife habitat were determined by overlaying the ungulate winter range, wildlife burn and riparian reserve coverages described in Section A.1, "Inventory information." A 90% reduction was applied to ungulate winter range and wildlife burn areas that occur outside of riparian reserves. In addition to riparian reserves and the 90% reduction, wildlife habitat management is also reflected in wildlife tree retention requirements, forest cover objectives for caribou habitat and grizzly zones, and through general forest cover constraints.

In February 1999, the government released the *Identified Wildlife Management Strategy*. The goals of the strategy are to minimize the impacts of forest practices on identified wildlife through the establishment of wildlife habitat areas (WHAs) and implementation of general wildlife measures. To date, three wildlife habitat areas totaling 177 hectares have been approved in the Dawson Creek TSA for mountain goat and bull trout. These areas were not considered in the timber supply analysis because they were approved after the analysis was initiated. However the potential impact on timber supply of these and possible future WHA's will be considered by the chief forester when he makes his determination.

A.3.15 Non-commercial deciduous species

In the past there have been large wildfires in the Dawson Creek TSA. Many of the burn areas have been mapped as not satisfactorily restocked polygons, and are occupied by non-commercial deciduous species, according to local silvicultural knowledge. These areas are identified as backlog NSR on the forest cover inventory file. With the exception of approximately 1500 hectares identified in Table A-21., "Rehabilitation activities," there are no plans to rehabilitate these areas and they therefore do not contribute to the timber harvesting land base assumed in the analysis.

A.4 Forest Management Assumptions

A.4.1 Utilization levels

Utilization levels define the maximum stump height, minimum top diameter (inside bark) and minimum diameter at breast height (dbh) by species and are used as inputs to the yield projections that were used in the timber supply analysis.

Table A-13. Utilization levels

Species	Minimum dbh (cm)	Maximum stump height (cm)	Minimum top dib (cm)
Spruce	17.5	30	10.0
Balsam	17.5	30	10.0
Pine	12.5	30	10.0
Pine (height class 2)	9.0	30	7.5
Aspen	12.5	30	10.0
Balsam poplar	12.5	30	10.0

For pine (height class 2) utilization, a minimum dbh of 9.0 cm is indicated. This criterion is based on MSRM, Terrestrial Information Inventory Branch's adaptation of the interior lodgepole pine taper equation.

A.4.2 Volume exclusions for mixed species stands

In the Dawson Creek TSA, unlike other areas of the province, all tree species of merchantable size within a cutblock are charged to cut control, and therefore contribute to timber supply under current management. Therefore, no reductions to yield estimates to account for unused secondary species were made.

A.4.3 Minimum harvestable age derivation

The minimum harvestable age is the age at which a stand is estimated to be available for harvest. Harvesting may occur in stands at the minimum harvestable age to meet a harvest target for a short period of time or avoid large and abrupt changes in harvest levels. However, most stands will not be harvested until past the minimum timber production ages because of management objectives for other resource values (e.g., requirements for the retention of older forest). Table A-14., lists the criteria used in defining minimum harvestable ages by leading species. Table A-15. shows the corresponding minimum harvestable age (and culmination age) by analysis unit. The four-digit analysis unit numbers are explained in Table A-4., "Dawson Creek TSA analysis units and regenerated stand species."

A.4 Forest Management Assumptions

Table A-14. Minimum harvestable age criteria

Leading species	Minimum criteria		
	Height class	Dbh (cm)	Volume (cubic metres per hectare)
Small pine	2	9.0	120
Other pine		12.5	120
Aspen		12.5	120
Balsam poplar		12.5	120
Spruce		17.5	120
Balsam		17.5	120

Table A-15. Dawson Creek TSA minimum harvestable ages

Analysis unit	Species composition	Productivity class	Minimum harvestable age (years)	Culmination age (years)
Existing natural unmanaged thrifty stands				
0111	Pure spruce	G	50	90
0121	Pure spruce	M	67	110
0131	Pure spruce	P	100	160
0231	Pure balsam	P	96	180
0311	Pure pine	G	51	80
0321	Pure pine	M	59	120
0331	Pure pine	P	81	130
0421	Pure small pine	M	63	130
0511	Pure aspen	G	47	80
0521	Pure aspen	M	57	90
0531	Pure aspen	P	78	100
0611	Pure balsam poplar	G	43	70
0621	Pure balsam poplar	M	52	90
0631	Pure balsam poplar	P	66	110
0711	Leading spruce	G	52	100
0721	Leading spruce	M	70	130
0731	Leading spruce	P	99	160
0811	Leading pine	G	51	80
0821	Leading pine	M	61	110
0831	Leading pine	P	83	130
0921	Leading small pine	M	66	130
1021	Leading balsam	M	65	110
1031	Leading balsam	P	101	160
1211	Leading aspen	G	45	80
1221	Leading aspen	M	57	90
1231	Leading aspen	P	76	100

(continued)

A.4 Forest Management Assumptions

Table A-15. Dawson Creek TSA minimum harvestable ages

Analysis unit	Species composition	Productivity class	Minimum harvestable age (years)	Culmination age (years)
1311	Leading balsam poplar	G	46	80
1321	Leading balsam poplar	M	58	100
1331	Leading balsam poplar	P	70	120
1511	Mix spruce	G	52	90
1521	Mix spruce	M	65	110
1531	Mix spruce	P	85	130
1611	Mix pine	G	60	90
1621	Mix pine	M	64	110
1631	Mix pine	P	83	130
1711	Mix conifer	G	58	100
1721	Mix conifer	M	67	110
1731	Mix conifer	P	80	130
1811	Mix aspen	G	48	90
1821	Mix aspen	M	60	100
1831	Mix aspen	P	81	110
1921	Mix balsam poplar	M	51	90
2011	Mix deciduous	G	50	90
2021	Mix deciduous	M	59	100
2031	Mix deciduous	P	80	120
5511	Pure aspen	G	46	80
5521	Pure aspen	M	59	90
5531	Pure aspen	P	76	100
5611	Leading aspen	G	46	80
5621	Leading aspen	M	58	90
5631	Leading aspen	P	76	100
Existing natural unmanaged old stands				
0122	Pure spruce	M	70	110
0132	Pure spruce	P	126	210
0232	Pure balsam	P	141	220
0422	Pure small pine	M	84	130
0722	Leading spruce	M	76	130
0732	Leading spruce	P	124	200
0822	Leading pine	M	81	120
0922	Leading small pine	M	88	130
1032	Leading balsam	P	133	200
Regenerating stands				
0114	Pure spruce	G	41	70
0124	Pure spruce	M	59	100
0134	Pure spruce	P	90	160
0224	Pure balsam	M	69	110
0234	Pure balsam	P	102	170
0314	Pure pine	G	34	60
0324	Pure pine	M	54	80
0334	Pure pine	P	91	120

(continued)

A.4 Forest Management Assumptions

Table A-15. Dawson Creek TSA minimum harvestable ages (concluded)

Analysis unit	Species composition	Productivity class	Minimum harvestable age (years)	Culmination age (years)
0424	Pure small pine	M	67	100
0514	Pure aspen	G	48	80
0524	Pure aspen	M	59	90
0534	Pure aspen	P	78	100
0614	Pure balsam poplar	G	43	70
0624	Pure balsam poplar	M	54	90
0634	Pure balsam poplar	P	66	110
1514	Mix spruce	G	39	70
1524	Mix spruce	M	52	90
1534	Mix spruce	P	72	120
1614	Mix pine	G	38	70
1624	Mix pine	M	52	80
1634	Mix pine	P	78	100
1714	Mix conifer	G	37	70
1724	Mix conifer	M	51	90
1734	Mix conifer	P	69	120
1814	Mix aspen	G	49	80
1824	Mix aspen	M	63	100
1834	Mix aspen	P	85	120
1924	Mix balsam poplar	M	56	100
2014	Mix deciduous	G	45	80
2024	Mix deciduous	M	62	100
2034	Mix deciduous	P	82	140
5514	Pure aspen	G	48	80
5524	Pure aspen	M	61	90
5534	Pure aspen	P	79	100

A.4.4 Harvest scheduling priorities

In the timber supply model, stands proposed for harvest within forest development plans were assigned the highest harvest priority during the first 20 years. The next highest priority was given to stands that were oldest relative to their respective minimum harvestable age. Salvage operations are considered a higher priority than harvesting of the timber profile. Therefore a minimum target of 50 000 cubic metres per 10–year period was also assigned to old spruce analysis units (0122, 0132, 0722, 0732) to simulate an annual salvage apportionment of 5000 cubic metres per year.

A.4 Forest Management Assumptions

A.4.5 Silvicultural systems

Table A-16. lists the silvicultural systems that are currently employed in the Dawson Creek TSA.

Table A-16. Silvicultural systems

Silvicultural system	Primary analysis units	Estimated annual harvest area (hectares)	Per cent (%) of harvest	Volume retained (%)	No. of harvest entries
Clearcut	1, 2, 3, 4, 7, 8, 9, 10, 15, 16, 17	3 310	53.5	0	1 at harvest rotation
Strip shelterwood	1, 7, 8, 10	1 095	17.7	10	1 at harvest rotation
Group selection	3, 7, 18, 19, 20	28	0.5	70	1 at harvest rotation
Coppice	5, 6, 12, 13, 18, 19, 20, 55, 56	1 751	28.3	0	1 at harvest rotation

Data source and comments:

The above table was based on a review of forest development plans in the TSA as well as TSR I information.

Both strip shelterwood and clearcut systems are employed within pure spruce, and spruce-, pine- or balsam-leading analysis units. Approximately one-third of areas within these analysis units are harvested using strip shelterwood rather than clearcut methods. To account for a potential 10% volume reduction at harvest on one-third of analysis units where strip shelterwood silvicultural systems may be employed, a sensitivity analysis was performed by applying a 3.34% reduction (10%*1/3) to the associated yield curves.

Because of the small estimated area harvested using group selection methods (28 hectares), these areas were modelled as even-aged stands.

A.4.6 Unsalvaged losses

Table A-17. shows the estimated average annual unsalvaged volume loss to catastrophic events such as insect epidemics, fires, wind and root disease on the timber harvesting land base. The volume indicated was removed from the modelled harvest forecasts and is intended to reflect only those volumes that will not be recovered or salvaged.

A.4 Forest Management Assumptions

Table A-17. Unsalvaged losses

Stand type grouping	Primary analysis unit	Cause of loss				
		Fire	Wind	Spruce beetle	*Innonotus tomentosus*	Total
Coniferous stands	2, 3, 8,10, 15, 16, 17	3 745	3 246			6 991
Spruce	1, 7	3 991	3 459	29 640	4 698	41 787
Small pine	4, 8	728	631			1 360
Deciduous-leading	5, 6, 12, 13, 18, 19, 20, 55, 56	4 690	4 064			8 754
Total		13 154	11 400	29 640	4 698	58 892

Data source and comments:

The Prince George Regional pathologist and entomologist provided estimates of total losses using forest health data specific to the Dawson Creek Forest District (i.e., 10-year annual average losses); unsalvaged losses were estimated using data from the Dawson Creek Forest District's salvage program (i.e., 5-year annual average losses). This information was supplemented with estimates in the *Forest Insect and Disease Survey, Canadian Forest Service*.

For fire and wind, the total losses were pro-rated to each applicable stand type based on the current area within the associated species groupings. Losses from *Innonotus tomentosus* root rot typically occurs in spruce stands under 700 metres elevation with an age greater than 100 years. The total loss of 4698 cubic metres per year was based on an estimated annual loss of 2.5 cubic metres per hectare per year multiplied by the current area considered susceptible (1879 hectares).

Access to timber for salvage within the Dawson Creek TSA is dependent on costs associated with development or road reactivation. Where development costs outweigh the value of damaged timber, volumes are deemed economically inaccessible and considered an unsalvaged loss.

A.4.7 Silviculture and regeneration activities

The silviculture program consists of the mix of treatments expected to be carried out to achieve basic silviculture on all sites. Table A-18. shows the silviculture regime, expected average regeneration delay, and operational adjustment factors (OAF) applicable to each analysis unit.

Timber volumes for regenerating conifer-leading stands were estimated using the B.C. Forest Service table interpolation program for stand yields (TIPSY) growth and yield model. Volumes for existing unmanaged and regenerating deciduous-leading stands were projected using the variable density yield prediction (VDYP) yield model. Where more than one regeneration method was planned for a given analysis unit, the associated yield tables was constructed by combining a number of tables.

Table A-18. contain the inputs required to produce the yield tables for this analysis and to model regeneration of stands after projected harvest.

A.4 Forest Management Assumptions

Table A-18. Regeneration assumptions by generalized analysis unit

Primary analysis unit	Composition	Regen delay (years)	OAF 1 (%)	OAF 2 (%)	Regeneration method Type	Regeneration method % of area	Species Code	Species %	Initial density (stems/ha)
1	Sx > 80%	4	15	5	Plant	100	Sw	100	1 600
2	Bl > 80%	4	15	5	Plant	100	Sw	100	1 600
			—	—	Natural	70[a]	Bl	100	3 000
3	Pl > 19.4 m > 80%	4	15	5	Plant	100	Pl	100	1 600
			—	—	Natural	5[a]	Pl	100	3 000
4	Pl ≤ 19.4 m > 80%	4	15	5	Plant	100	Pl	100	1 600
			—	—	Natural	5[a]	Pl	100	3 000
7	Sx >50% and ≤ 80%	4	15	5	Plant	100	Sw	100	1 600
8	Pl > 19.4 m, > 50% and ≤ 80%	4	15	5	Plant	100	Pl	100	1 600
			—	—	Natural	5[a]	Pl	100	3 000
9	Pl ≤ 19.4 m	4	15	5	Plant	100	Pl	100	1 600
			—	—	Natural	5[a]	Pl	100	3 000
10	Bl > 50% and ≤ 80%	4	15	5	Plant	100	Sw	100	1 600
			—	—	Natural	70[a]	Bl	100	3 000
15	Sx > 50% > and ≤ 80% and At/Ac ≤ 50%	4	15	5	Plant	80	Sw	100	1 600
		2	—	—	Natural	20	At	100	20 000
16	Pl> 19.4 m, > 50 and ≤ 80% and At/Ac ≤ 50%	42	15	5	Plant	80	Pl	100	1 600
			—	—	Natural	20	At	100	20 000
17	Conifer > 50%, Decid ≤ 50%	4	15	5	Plant	80	Sw	50	1 600
		2					Pl	50	1 600
			—	—	Natural	20	At	100	20 000
5, 55	At > 80%	3	—	—	Natural	100	At	100	20 000
6	Ac > 80%	3	—	—	Natural	100	Ac	100	5 000
12, 56	At > 50% and ≤ 80%	3	—	—	Natural	100	At	100	20 000
13	Ac > 50% and ≤ 80%	3	—	—	Natural	100	Ac	100	5 000
18	At > 50% and ≤ 80%	3	—	—	Natural	80	At	100	20 000
		4	15	5	Plant	20	Sw	100	1 600
19	Ac > 50% and ≤ 80%	3	—	—	Natural	80	Ac	100	5 000
		4	15	5	Plant	20	Sw	100	1 600
20	Deciduous % > Conifer %	3	—	—	Natural	80	At	50	20 000
		3	—	—			Ac	50	5 000
		4	15	5	Plant	20	Sw	100	1 600

(a) Reflects proportion of area subject to natural ingress and advance regeneration of balsam fir (primary AUs 2 and 10) or lodgepole pine (primary AUs 3, 4, 8 and 9).

A.4 Forest Management Assumptions

Regenerating stands are established through a combination of planting and natural regeneration. In the timber supply analysis, additional densities of natural balsam (subalpine) fir or pine regeneration were assumed to occur on all or a portion of primary analysis units 2-4, 8-10, and 15-20. Initial density estimates were based on survey records and local MoF and conifer licensee silviculture knowledge. Yield curves for theses analysis units were derived by developing separate yield curves for the naturally regenerated and planted components. The resulting curves were then area-weighted by the percentages indicated in Table A-18.

Approximately 15% of pure balsam, balsam-leading, pure spruce and spruce-leading stands that are harvested using a strip shelterwood silviculture system in the ESSF support advance regeneration of balsam fir. To ensure that spruce is included as a stand component for economic considerations, these stands are planted to spruce. It is anticipated that balsam fir will develop as a co-dominant stand component, and will compete with the planted spruce. The resultant stand is expected to represent a conifer mixed-wood.

Use of class A seed is limited to silviculture trials within the ESSFwk2. Therefore no genetic gain was assumed in the analysis.

An area-weighted regeneration delay period was estimated for each analysis unit using ISIS/MLSIS records. Estimates were developed for post-1987 silviculture openings; and for naturally and artificially regenerated stands.

Operational adjustment factors (OAFs) are used to adjust timber yield estimates to account for operational factors. OAF1 is a constant percentage reduction to account for small stocking gaps within stands. OAF2 accounts for losses that increase with stand age, for example decay due to disease. Provincial average operational adjustment factors (OAFs) values were applied to the managed stand yield curves in the base case.

A.4.8 Immature plantation history

All conifer stands aged 12 years and under in the Dawson Creek TSA have had some form of density control (i.e., brushing) or plantability/stocking survey which indicates the stands are well-spaced or free-growing, and therefore are considered to be managed. Table A-19. summarizes these stands by analysis unit and area.

Table A-19. Summary of immature plantations

Analysis unit	Species description	Area (hectares)
0124	Pure spruce	23 934
0224	Spruce-balsam	2 113
0324	Pure pine	15 163
1524	Spruce-aspen	2 256
1624	Pine-aspen	413
1724	Spruce-pine-aspen	2024
2024	Aspen-balsam poplar-spruce	671
Total		47 660

Data source and comments:

All deciduous stands and any conifer stands harvested over 12 years ago are considered to be unmanaged. Stands harvested over 12 years ago were either clearcut or partially harvested using diameter-limit selection systems, and were allowed to regenerate naturally. Similarly, existing deciduous stands are typically clearcut and allowed to regenerate naturally; therefore their growth and yield was projected using a natural (unmanaged) stand yield model (VDYP).

A.4 Forest Management Assumptions

A.4.9 Not satisfactorily restocked (NSR) areas

Type identity classifications of 4 or 9 identify the land base that is not satisfactorily restocked (NSR). A NSR label is used to denote forest lands that are not growing to their full potential due to insufficient stocking of preferred and/or acceptable tree species.

Approximately 42 848 hectares of the total forested area in the Dawson Creek TSA is identified as NSR on the forest inventory file. Although ISIS and MLSIS were initially used to estimate NSR area by analysis unit, it was difficult to reconcile the estimates with the polygon-level information available on the forest inventory file. Therefore an alternative approach was used as follows.

Much of the NSR on the inventory file had a projected age of zero. Since it is known that this age often does not reflect actual conditions, a "logging-based age", derived using harvesting history information was used to better identify and distribute the NSR into annual ages and reflect activity levels across landscape units.

Based on the projected age (or logging-based age, where the projected age was zero), stands were identified as 'current' NSR (26 538 hectares) or pre-1987 'backlog' NSR (16 310 hectares). Current NSR was then assigned to analysis units according to the initial proportion of existing (sufficiently stocked) regenerating stands in the timber harvesting land base. A total of 26 538 hectares of current NSR were assigned as follows:

Table A-20. Current not-satisfactorily-restocked (NSR) areas

Analysis unit number	Description	Area (hectares)
0124	Spruce	13 800
0324	Pine	9 554
1724	Spruce-pine-aspen	1 858
0224	Spruce-balsam	1 327
	Total	26 538

Only a small proportion of the areas identified as backlog NSR were assumed to contribute to the timber harvesting land base. District staff advise that much of the area — although labeled NSR — is occupied by non-commercial deciduous species according to local silviculture knowledge. As a result only those 'backlog' areas identified in Section A.4.10, "Rehabilitation activities" (1489 hectares) were assumed to contribute to timber harvesting. The balance of the areas classified as backlog (14 821 hectares) was excluded from the timber harvesting land base as non-commercial deciduous species.

A.4.10 Rehabilitation activities

As described above, the Dawson Creek TSA includes areas classified as backlog NSR that do not currently contribute to timber production. The current silviculture program includes plans to rehabilitate approximately 1500 hectares of the backlog NSR areas. Table A-21. summarizes the rehabilitation treatment schedule and the analysis unit assignments.

A.4 Forest Management Assumptions

Table A-21. Rehabilitation activities

Target rate of rehabilitation (hectares/decade)	Rehabilitation criteria	Actual area assigned (hectares)	Actual age assignment (years)	Rehabilitated to	
				Analysis unit #	Description
1000 hectares during decade 1	Backlog NSR	1 058	–5	1524	Spruce–aspen
500 hectares during decade 2	Backlog NSR	431	–15	1524	Spruce–aspen
1500 hectares total		1 489			

Data source and comments:

Backlog (pre-1987) areas currently designated as NSR are being rehabilitated and planted with conifer growing stock. Some of these sites, although labeled NSR, are occupied by non-commercial deciduous species according to local silviculture knowledge.

The Dawson Creek Forest District intends to rehabilitate (i.e., mechanically site prepare and plant to spruce) only small proportion of the total backlog NSR area. According to district staff, priority areas for treatment were those openings that previously supported pure spruce stands. In the analysis, the entire rehabilitated area was assigned to analysis unit 1524. All other stands were excluded from the timber harvesting land base assumed in the analysis.

A.4.11 Forest cover requirements — integrated resource management

The timber supply model used (FSSIM Version 4.1) can incorporate forest cover requirements that specify both the maximum proportion of an area allowed in a disturbed condition, and the minimum required area of old-age forest. As noted in Section A.2.1, "Management zones", forest cover requirements were applied to model management for a number of objectives. Where a management group (e.g., retention VQO) spans more than one landscape unit, the forest cover requirements were modelled at the landscape unit level.

Table A-22. lists the forest cover requirements that were applied in the various zones to represent current management. The forest cover requirements were applied to each zone within each landscape unit.

A.4 Forest Management Assumptions

Table A-22. Forest cover requirements

Zone	Maximum allowable disturbance (% area)	Green-up height (metres)	Minimum retained area (%)	Minimum age or height for retention	Area of application	Source of prescription
Integrated resource management areas	33	3		Age to achieve green-up heights were generated using SiteTools version 3.2i	Timber harvesting land base (THLB)	Application of cutblock adjacency requirements for TSA by landscape unit (LU)
VQO: Preservation Retention Partial retention Modification Maximum modification	 1 5 10 20 33	 5 5 5 5 5		Age to achieve green-up heights were generated using SiteTools version 3.2i	Crown forested area	MoF *Procedures for Factoring Visual Resources into Timber Supply Analyses*
Caribou management zone	33	3	44% of which 11%	mature+old seral old seral	Crown forested area	Expert advice from Dale Seip (MoF); Randy Sulyma / Darwyn Coxson (UNBC) and Dave King, (ex MELP)
Grizzly bear management zone	33	3	Early seral retention % for 'Intermediate' biodiversity emphasis in NDTs 1 and 2	Early seral age for 'Intermediate' biodiversity emphasis in NDTs 1 and 2	Crown forested area	Expert advice from Dale Seip (MoF) and Dave King, (ex MELP)

A.4 Forest Management Assumptions

Data source and comments:

Habitat requirements of caribou and grizzly bear are consistent with the Dawson Creek LRMP. Caribou habitat is managed to ensure that an area greater than 44% of the Crown forested land base is retained in mature plus old seral forest, and of this area, at least 11% is retained in an old seral condition.

Grizzly bear habitat is managed to retain early seral forest based on percentages specified in the *Biodiversity Guidebook* for an intermediate biodiversity emphasis in NDTs 1 and 2. Early seral conditions are important to ensure adequate foraging habitat for grizzly bears. Interim strategies for managing grizzly bear habitat include vegetation management, one-sided drainage development, and seasonal access constraints.

Green-up was modelled as the age at which the associated green-up height is estimated to be achieved. The B.C. Forest Service SiteTools model was used to estimate green-up age of each stand. The average area-weighted age by VQO and landscape unit was calculated and used in the timber supply analysis.

A.4.11.1 Landscape-level biodiversity

Both old seral and, where applicable according to provincial policy (see Table A-23.), mature-plus-old seral guidelines were modelled in the base case. Landscape units and biodiversity emphasis options (BEO) are draft, however, they were modelled in the base case. Table A-23. lists the draft landscape units and BEOs assumed in the analysis.

A.4 Forest Management Assumptions

Table A-23. Draft landscape units and biodiversity emphasis assignment

Landscape unit number	Landscape unit name	Draft biodiversity emphasis	Total forested area (hectares)
1	Eastpine	Lower	18
2	Martin Creek	Lower	542
3	Bearhole	Intermediate	94 660
4	Highhat	Lower	3
5	Boucher	Lower	106
6	Septimus	Intermediate	49 758
7	Kiskatinaw	Lower	58 872
8	Dawson Creek	Lower	25 383
9	Pine River	Lower	53 972
10	Upper Moberly	Intermediate	86 146
11	Puggins	Lower	106 792
12	One Island	Lower	154 650
13	Gwillim	Intermediate	112 867
14	Wolverine	Intermediate	48
15	Redwillow	Higher	88 601
16	Kinuseo	Intermediate	91 501
17	Imperial-Monkman	Higher	62 754
18	Wapiti	Intermediate	83 639
19	Dunlevey	Higher	322
20	Lower Moberly	Lower	64 176
21	Gething	Lower	354
22	Carbon	Intermediate	146
23	Pine Pass	Intermediate	86 439
24	Burnt-Lemoray	Intermediate	62
25	Upper Sukunka	Lower	51 802
26	Belcourt	Intermediate	63 747
27	Narraway	Higher	41 524
28	Hudson's Hope	Lower	57 062
	Total		**1 435 946**

A.4 Forest Management Assumptions

The landscape-level biodiversity requirements were modelled at the biogeoclimatic unit, natural disturbance type (NDT) level. For NDT3 units, different landscape-level biodiversity requirements are defined for predominantly deciduous and predominantly coniferous forests. For lower BEOs, the forest cover requirements were phased in — i.e., one-third of the value for the first rotation (0-70 years), two-thirds for the second rotation and the full requirement for the remainder of the planning horizon (141+ years).

A sensitivity analysis was performed to investigate the impacts of a 45-45-10 per cent distribution of lower, intermediate and higher biodiversity emphasis. Table A-24. presents the old seral and mature-plus-old seral stage requirements by biogeoclimatic unit and NDT based on the *Landscape Unit Planning Guide.*

Table A-24. Landscape unit biodiversity requirements within the Dawson Creek TSA.

			Mature and old-seral stage		Old-seral stage			
					Minimum retention area (%)			
Biogeoclimatic unit	NDT	Biodiversity emphasis	Minimum retention area (%)	Minimum age (years)	Now	71 years	141 years	Minimum age (years)
ESSF	1	Lower	–	–	6.3	12.7	19	250
		Intermediate	–	–	19	19	19	250
		Higher	–	–	28	28	28	250
		45/45/10 L/I/H	–	–	14.2	17.1	19.9	250
ESSF	2	Lower	–	–	3	6	9	250
		Intermediate	–	–	9	9	9	250
		Higher	–	–	13	13	13	250
		45/45/10 L/I/H	–	–	6.7	8.1	9.4	250
SBS	2	Lower	–	–	3	6	9	250
		Intermediate	–	–	9	9	9	250
		Higher	–	–	13	13	13	250
		45/45/10 L/I/H		–	6.7	8.1	9.4	250
BWBS-c[a]	3	Lower	11	100	3.7	7.3	11	140
		Intermediate	23	100	11	11	11	140
		Higher	34	100	16	16	16	140
		45/45/10 L/I/H	18.7	–	8.2	9.9	11.5	140
BWBS-d[b]	3	Lower	13	80	4.3	8.6	13	100
		Intermediate	23	80	13	13	13	100
		Higher	34	80	19	19	19	100
		45/45/10 L/I/H	19.6	–	9.7	11.7	13.6	100

(a) BWBS with coniferous species prominent.

(b) BWBS with deciduous species prominent.

A.4 Forest Management Assumptions

A.4.11.2 Wildlife trees (WT) and wildlife tree patches (WTP)

The *Landscape Unit Planning Guide* describes two methods for maintaining stand structure over time. One method uses wildlife trees (WTs) while the other uses wildlife tree patches (WTPs). The Dawson Creek Forest District's current practice is the retention of wildlife tree patches. Because of extensive windthrow hazard, the retention of individual wildlife trees is uncommon.

As part of local landscape unit planning, an assessment of the area recommended for WTP retention was performed. The assessment was consistent with the *Dawson Creek Draft Landscape Unit Planning Strategy* (June 1999), and the provincial *Landscape Unit Planning Guide (Table A3.1)*.

The recommended retention levels are shown in the column three of Table A-25. and are area-weighted by landscape unit. According to the May 15, 2000 memorandum from Ministry of Forests and (at that time) Ministry of Environment, Lands and Parks assistant deputy ministers regarding provincial wildlife tree patches recommendations, it was assumed for the analysis that 50% of the overall wildlife tree patch requirements will be achieved on the timber harvesting land base.

A.4 Forest Management Assumptions

Table A-25. Reductions to reflect volume retention in cutblocks

Landscape unit (LU)		Total estimated WTP requirement (%)	% reduction [a] applied in the analysis
Number	Name		
1	Eastpine	7.0	3.5
2	Martin Creek	7.0	3.5
3	Bearhole	6.0	3.0
4	Highhat	7.0	3.5
5	Boucher	6.0	3.0
6	Septimus	7.0	3.5
7	Kiskatinaw	7.0	3.5
8	Dawson Creek	7.0	3.5
9	Pine River	7.0	3.5
10	Upper Moberly	7.0	3.5
11	Puggins	6.0	3.0
12	One Island	6.0	3.0
13	Gwillim	6.0	3.0
14	Wolverine	7.0	3.5
15	Redwillow	4.0	2.0
16	Kinuseo	4.0	2.0
17	Imperial-Monkman	3.0	1.5
18	Wapiti	4.0	2.0
19	Dunlevey	6.0	3.0
20	Lower Moberly	6.0	3.0
21	Gething	8.0	4.0
22	Carbon	8.0	4.0
23	Pine Pass	6.0	3.0
24	Burnt-Lemoray	8.0	4.0
25	Upper Sukunka	5.0	2.5
26	Belcourt	4.0	2.0
27	Narraway	5.0	2.5
28	Hudson's Hope	6.0	3.0

(a) The landscape unit strategy recommendations were employed in the analysis, with the assumption that half of the requirement would be achieved outside the timber harvesting land base. The reductions were applied to each resultant polygon.

A.4 Forest Management Assumptions

4.11.3 Livestock grazing

Livestock grazing is an important activity within the Dawson Creek TSA. Grazing activities occur on areas subject to Crown grazing leases, grazing permits and community pastures. Tree productivity loss associated with cattle grazing has not been quantified for the Dawson Creek TSA, and yield projections cannot be confidently adjusted to reflect cattle grazing impacts. Similarly, the relative gain in tree productivity associated with deferring cattle grazing in the short term is unknown.

Sensitivity analysis was used to examine the impacts of lower stocking at free-growing on a portion of the grazed area. Community pastures were combined with range tenures (grazing permit areas and grazing leases) in a sensitivity analysis to simulate lower yields associated with reduced stocking levels on approximately 30% of grazing areas.

A.5 Volume Estimates for Existing Stands

The variable density yield projection (VDYP) model, version 6.6d supported by the Ministry of Sustainable Resource Management, Terrestrial Information Branch, was used to estimate timber volumes for existing natural stands, and for regenerated deciduous stands. Table A-26. shows the volume estimates by analysis unit for existing natural stands.

Table A-26. Timber volume tables for existing natural stands (cubic metres/hectare)

Age (years)	Analysis units (existing stands)								
	0111	0121	0122	0131	0132	0231	0232	0311	0321
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	28	1
40	45	3	2	0	0	1	0	76	34
50	123	34	24	1	0	17	1	118	81
60	189	84	73	5	1	39	9	155	125
70	245	132	121	27	8	66	25	188	165
80	292	175	163	58	23	89	41	217	201
90	330	212	200	91	40	109	55	244	235
100	361	243	231	121	61	127	69	268	266
110	387	271	258	149	84	144	81	290	295
120	408	295	282	174	106	159	93	311	322
130	427	316	303	198	128	176	106	331	348
140	444	336	322	219	148	192	118	343	365
150	457	352	338	239	167	208	130	353	378
160	469	367	353	256	185	224	142	359	388
170	479	380	366	272	201	238	153	363	394
180	487	391	377	287	216	253	164	364	396
190	494	401	387	300	231	266	174	362	394
200	500	410	396	312	244	280	184	363	397
210	505	418	404	323	256	293	194	365	400
220	510	426	411	333	268	305	204	367	403
230	514	432	418	343	278	317	213	370	406
240	517	438	424	351	288	329	222	372	409
250	520	443	429	359	298	340	231	374	412
260	522	447	432	366	305	341	231	376	414
270	524	451	436	372	313	342	232	378	417
280	525	454	439	378	320	342	233	380	419
290	527	457	441	384	326	343	233	381	421
300	528	459	444	388	332	343	234	383	423
310	529	461	445	393	337	344	234	384	424
320	529	463	447	397	342	344	235	386	426
330	530	464	449	401	347	345	235	387	427
340	530	466	450	404	351	345	236	388	428
350	530	467	451	407	355	346	236	389	429

Analysis unit legend:
1st and 2nd digit = primary analysis unit (spruce = 1, 7; balsam = 2, 10; pine = 3,4,8,9; aspen = 5, 12 ,55 ,56; balsam poplar = 6, 13, mixed-wood = 15-20);
2nd digit = relative productivity rating (G = 1; M = 2; P = 3);
3rd digit = stand class (thrifty = 1; old = 2, existing and future managed = 4).

(continued)

A.5 Volume Estimates for Existing Stands

Table A-26. Timber volume tables for existing natural stands (cubic metres/hectare)

Age (years)	Analysis units (existing stands)								
	0331	0421	0422	0511	0521	0531	0611	0621	0631
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	0	0	0	20	3	0	22	1	0
40	0	10	0	78	40	4	100	33	0
50	16	59	14	137	87	33	165	105	40
60	50	106	47	193	133	66	217	165	93
70	85	151	79	245	176	99	258	216	140
80	118	192	109	285	210	126	291	258	180
90	149	230	137	320	240	149	318	294	215
100	179	267	164	348	263	168	341	324	246
110	207	300	189	369	281	183	359	350	273
120	233	332	213	383	294	194	374	371	296
130	259	363	236	390	300	200	386	390	316
140	277	383	252	401	308	207	397	407	334
150	291	400	265	410	316	212	406	421	350
160	302	412	274	410	316	213	406	421	350
170	310	419	281	410	316	213	407	421	350
180	314	422	284	410	316	213	407	422	350
190	314	421	284	410	316	214	407	422	350
200	318	425	288	410	316	214	407	422	351
210	322	429	291	410	316	214	407	422	351
220	326	433	295	410	316	214	408	422	351
230	329	437	298	410	316	214	408	423	351
240	333	441	301	410	317	215	408	423	351
250	336	444	304	411	317	215	408	423	351
260	339	447	306	411	317	215	408	423	351
270	341	450	309	411	317	215	408	423	351
280	344	453	311	411	317	215	408	423	351
290	346	455	313	411	317	215	408	423	351
300	348	457	314	411	317	215	408	423	352
310	349	459	316	411	317	215	408	423	352
320	351	460	317	411	317	216	408	423	352
330	352	462	318	411	317	216	408	423	352
340	352	463	318	411	317	216	408	423	352
350	353	463	319	411	317	216	408	424	352

Analysis unit legend:
1st and 2nd digit = primary analysis unit (spruce = 1, 7; balsam = 2, 10; pine = 3,4,8,9; aspen = 5, 12 ,55 ,56; balsam poplar = 6, 13, mixed-wood = 15-20);
2nd digit = relative productivity rating (G = 1; M = 2; P = 3);
3rd digit = stand class (thrifty = 1; old = 2; existing and future managed = 4).

(continued)

A.5 Volume Estimates for Existing Stands

Table A-26. Timber volume tables for existing natural stands (cubic metres/hectare)

Age (years)	Analysis units (existing stands)								
	0711	0721	0722	0731	0732	0811	0821	0822	0831
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	24	1	1	0
40	35	1	2	0	0	73	29	10	1
50	107	24	16	1	0	117	75	35	13
60	173	71	55	7	3	155	118	65	45
70	231	120	98	29	13	188	156	93	79
80	281	164	138	59	28	217	190	119	111
90	324	203	172	92	48	243	221	142	140
100	361	238	203	122	69	266	249	163	168
110	392	269	229	150	91	286	275	182	193
120	419	296	253	176	111	305	298	200	216
130	442	321	276	201	132	322	320	217	239
140	460	342	295	223	151	334	335	229	255
150	475	360	312	242	169	343	348	239	269
160	487	374	327	260	186	350	357	247	279
170	497	387	340	275	201	353	363	252	287
180	504	397	351	289	215	355	366	256	292
190	510	405	361	300	228	354	366	257	295
200	516	414	370	312	241	356	369	260	299
210	521	421	378	323	252	358	373	264	304
220	526	428	386	332	263	361	376	267	308
230	530	434	393	341	273	363	379	270	312
240	534	440	399	350	283	365	382	273	316
250	537	445	405	358	291	367	385	275	320
260	540	449	409	364	297	369	388	278	323
270	542	453	413	369	303	371	390	280	326
280	545	456	416	374	308	373	392	281	328
290	547	459	418	379	313	374	394	283	331
300	548	462	421	383	318	375	396	285	333
310	550	464	423	387	322	377	398	286	335
320	551	466	425	391	326	378	399	287	336
330	552	468	427	394	329	379	400	289	338
340	553	470	428	397	333	380	401	289	339
350	553	471	429	399	336	381	402	290	340

Analysis unit legend:
1st and 2nd digit = primary analysis unit (spruce=1, 7; balsam = 2, 10; pine = 3,4,8,9; aspen = 5, 12 ,55 ,56; balsam poplar = 6, 13, mixed-wood = 15-20);
2nd digit = relative productivity rating (G = 1; M = 2; P = 3);
3rd digit = stand class (thrifty = 1; old = 2; existing and future managed = 4).

(continued)

A.5 Volume Estimates for Existing Stands

Table A-26. Timber volume tables for existing natural stands (cubic metres/hectare)

Age (years)	Analysis units (existing stands)								
	0921	0922	1021	1031	1032	1211	1221	1231	1311
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	0	0	4	0	0	21	2	0	12
40	7	1	25	1	0	87	37	2	80
50	50	8	61	9	2	148	86	32	145
60	95	39	99	27	10	204	133	69	201
70	137	70	138	54	26	255	175	104	247
80	175	99	171	78	43	294	209	132	284
90	210	126	198	99	59	328	238	157	316
100	242	151	224	118	74	355	262	178	341
110	271	174	246	135	89	377	281	195	362
120	298	196	267	151	102	392	296	209	379
130	324	216	289	168	116	402	305	218	393
140	343	232	310	184	129	413	316	228	404
150	357	244	329	200	141	423	325	236	415
160	368	254	347	214	153	423	326	237	415
170	376	261	363	227	165	424	326	238	415
180	380	266	379	240	176	424	327	239	416
190	381	269	393	252	186	424	327	240	416
200	385	273	407	264	196	425	328	240	416
210	389	277	421	275	206	425	328	241	416
220	394	282	434	286	215	425	328	242	416
230	398	286	446	296	224	425	329	242	416
240	401	289	458	306	233	426	329	243	416
250	405	293	469	316	242	426	329	243	416
260	408	296	471	318	244	426	330	244	417
270	411	298	474	321	246	426	330	244	417
280	414	301	476	323	247	426	330	245	417
290	416	303	478	325	249	427	330	245	417
300	418	305	479	326	251	427	330	245	417
310	420	307	481	328	252	427	331	245	417
320	422	308	483	330	253	427	331	246	417
330	423	310	484	331	255	427	331	246	417
340	424	311	485	333	256	427	331	246	417
350	426	312	487	334	257	427	331	246	417

Analysis unit legend:
1st and 2nd digit = primary analysis unit (spruce = 1, 7; balsam = 2, 10; pine = 3, 4, 8, 9; aspen = 5, 12 ,55 ,56; balsam poplar = 6, 13, mixed-wood = 15-20);
2nd digit = relative productivity rating (G = 1; M = 2; P = 3);
3rd digit = stand class (thrifty = 1; old = 2; existing and future managed = 4).

(continued)

A.5 Volume Estimates for Existing Stands

Table A-26. Timber volume tables for existing natural stands (cubic metres/hectare)

Age (years)	Analysis units (existing stands)								
	1321	1331	1511	1521	1531	1611	1621	1631	1711
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	11	1	0	1
40	22	0	33	3	0	46	22	1	19
50	79	25	103	37	3	85	62	17	72
60	133	73	172	92	26	120	105	46	132
70	181	119	230	144	64	151	144	81	187
80	221	160	279	190	103	177	177	111	235
90	256	197	320	228	139	201	207	138	278
100	286	229	352	261	170	222	234	163	313
110	311	258	378	288	198	241	258	185	343
120	332	283	399	311	221	258	280	206	369
130	349	304	417	330	243	272	299	224	390
140	365	323	433	348	261	282	313	238	407
150	379	341	447	363	278	290	323	249	422
160	379	342	455	372	289	294	329	255	430
170	380	343	461	380	298	297	333	259	437
180	380	344	467	387	307	297	334	261	442
190	381	344	472	393	314	296	333	261	445
200	381	345	477	398	321	297	335	264	449
210	381	346	480	403	327	298	337	266	453
220	381	346	484	407	333	300	339	268	456
230	382	347	486	411	338	301	341	270	459
240	382	347	489	414	342	303	343	272	462
250	382	348	491	417	346	304	345	274	464
260	382	348	493	419	350	306	347	276	467
270	382	349	494	422	353	307	348	278	469
280	383	349	495	424	356	308	350	279	470
290	383	349	496	425	359	309	351	281	472
300	383	350	497	427	361	310	353	282	473
310	383	350	498	428	363	311	354	283	474
320	383	350	498	429	365	312	355	284	475
330	383	351	499	430	366	313	355	284	476
340	383	351	499	430	368	314	356	285	477
350	383	351	499	431	369	314	357	286	478

Analysis unit legend:
1st and 2nd digit = primary analysis unit (spruce = 1, 7; balsam = 2, 10; pine = 3, 4, 8, 9; aspen = 5, 12 ,55 ,56; balsam poplar = 6, 13, mixed-wood = 15-20);
2nd digit = relative productivity rating (G = 1; M = 2; P = 3);
3rd digit = stand class (thrifty = 1; old = 2; existing and future managed = 4).

(continued)

A.5 Volume Estimates for Existing Stands

Table A-26. Timber volume tables for existing natural stands (cubic metres/hectare)

Age (years)	Analysis units (existing stands)								
	1721	1731	1811	1821	1831	1921	2011	2021	2031
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	1	0	11	2	0	7	12	2	0
40	16	2	72	27	1	50	61	25	1
50	48	20	136	75	21	117	123	74	16
60	91	51	196	122	55	173	183	123	54
70	135	87	250	166	89	222	235	168	89
80	173	119	294	202	118	264	279	207	119
90	207	149	332	234	144	300	316	241	147
100	238	175	363	261	167	331	346	270	172
110	264	198	388	283	186	357	370	294	193
120	287	219	407	301	201	381	390	315	212
130	308	238	421	314	214	401	406	332	228
140	324	252	435	326	224	419	420	347	241
150	338	265	447	337	233	435	432	360	252
160	346	272	451	341	237	439	436	365	257
170	352	278	455	344	241	442	440	369	260
180	357	282	457	346	243	445	443	372	263
190	359	285	459	347	244	447	445	374	264
200	363	288	461	349	246	449	448	377	266
210	367	292	463	351	248	451	450	379	269
220	371	295	465	353	250	453	452	382	271
230	374	298	466	354	252	455	453	384	273
240	377	301	468	356	254	456	455	386	275
250	380	304	469	357	255	458	456	388	276
260	382	306	470	358	256	459	457	389	278
270	384	308	472	359	258	460	458	391	279
280	386	310	473	360	259	462	459	392	281
290	388	312	473	361	260	463	460	393	282
300	390	314	474	362	261	464	460	394	283
310	391	315	475	363	261	464	461	395	284
320	393	317	476	363	262	465	461	396	285
330	394	318	476	364	263	466	462	397	285
340	395	319	477	364	263	466	462	397	286
350	396	320	477	365	264	467	462	398	287

Analysis unit legend:
1st and 2nd digit = primary analysis unit (spruce = 1, 7; balsam = 2, 10; pine = 3, 4, 8, 9; aspen = 5, 12 ,55 ,56; balsam poplar = 6, 13, mixed-wood = 15-20);
2nd digit = relative productivity rating (G = 1; M = 2; P = 3);
3rd digit = stand class (thrifty = 1; old = 2; existing and future managed = 4).

(continued)

A.5 Volume Estimates for Existing Stands

Table A-26. Timber volume tables for existing natural stands (cubic metres/hectare) (concluded)

Age (years)	Analysis units (existing stands)					
	5511	5521	5531	5611	5621	5631
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	24	2	0	17	1	0
40	86	36	4	85	35	2
50	148	82	36	147	84	35
60	206	126	71	204	128	71
70	261	169	105	256	169	104
80	302	202	132	296	202	132
90	338	231	155	330	230	156
100	367	254	175	357	253	176
110	389	272	190	379	271	193
120	403	283	200	394	285	205
130	410	289	206	403	294	215
140	420	297	213	415	304	224
150	429	304	219	425	313	232
160	429	304	219	426	314	233
170	430	305	219	426	314	234
180	430	305	219	427	314	234
190	430	305	219	428	314	234
200	430	305	219	428	315	235
210	430	305	220	429	315	235
220	430	305	220	429	315	236
230	430	305	220	429	315	236
240	430	305	220	430	316	236
250	430	305	220	430	316	237
260	430	305	220	430	316	237
270	430	305	220	430	316	237
280	430	305	220	431	316	237
290	431	305	220	431	316	237
300	431	305	220	431	317	238
310	431	305	220	431	317	238
320	431	305	220	431	317	238
330	431	305	220	431	317	238
340	431	305	220	432	317	238
350	431	305	220	432	317	238

Analysis unit legend:
1st and 2nd digit = primary analysis unit (spruce = 1, 7; balsam = 2, 10; pine = 3, 4, 8, 9; aspen = 5, 12 ,55 ,56; balsam poplar = 6, 13, mixed-wood = 15-20);
2nd digit = relative productivity rating (G = 1; M = 2; P = 3);
3rd digit = stand class (thrifty = 1; old = 2; existing and future managed = 4).

A.6 Volume Estimates for Regenerated Stands

The Table Interpolation Program for Stand Yields (TIPSY) batch version 3.1a, supported by the B.C. Ministry of Forests, Research Branch, was used to estimate growth and yield for existing and future managed coniferous stands. Existing managed stands were assumed to be all conifer stands with an age of 12 years or less, and future managed stands represented all coniferous stands regenerated in the analysis. VDYP was used to estimate the growth and yield of all existing and future regenerated deciduous stands. To develop curves for mixed-wood analysis units, or where more than one regeneration method was planned for a given analysis unit, the yield table was constructed by combining a number of tables.

Table A-27. Projected volumes for regenerating stands (cubic metres/hectare)

	Analysis units (regenerating stands)								
Age (years)	0114	0124	0134	0224	0234	0314	0324	0334	0424
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	10	0	0	0
30	11	0	0	0	6	86	10	0	2
40	104	6	0	0	40	176	49	2	20
50	219	51	0	16	107	248	100	19	54
60	328	126	7	62	165	310	150	44	93
70	405	197	32	129	215	348	188	68	131
80	454	260	72	196	256	381	221	94	159
90	484	325	118	255	290	409	247	117	186
100	506	373	164	313	319	431	270	138	207
110	518	406	204	361	342	447	291	156	226
120	519	432	241	393	361	456	306	172	240
130	522	451	278	421	376	462	316	184	254
140	521	464	315	439	390	465	326	195	267
150	522	477	344	455	402	466	333	205	277
160	518	485	370	467	402	466	340	214	284
170	515	491	386	479	402	466	346	220	293
180	515	497	402	484	402	466	350	225	297
190	515	498	414	492	402	467	354	231	300
200	515	495	423	495	402	467	358	237	304
210	515	495	432	496	402	467	362	240	306
220	515	492	438	497	402	467	365	243	308
230	515	492	443	495	402	467	367	245	310
240	515	490	447	497	402	467	370	248	313
250	515	486	452	497	402	467	372	252	315
260	515	486	454	491	402	467	371	253	316
270	515	486	456	491	402	467	366	256	318
280	515	483	458	488	402	467	365	257	319
290	515	482	460	484	402	467	361	258	315
300	515	482	460	484	402	467	361	259	314

Analysis unit legend:
1st and 2nd digit=primary analysis unit (spruce = 1, 7; balsam = 2, 10; pine = 3, 4, 8, 9; aspen = 5, 12 , 55 ,56; balsam poplar = 6, 13, mixed-wood = 15-20);
2nd digit = relative productivity rating (G = 1; M = 2; P = 3);
3rd digit = stand class (thrifty = 1; old = 2; existing and future managed = 4).

(continued)

A.6 Volume Estimates for Regenerated Stands

Table A-27. Projected volumes for regenerating stands (cubic metres/hectare)

Age (years)	Analysis units (regenerating stands)								
	0514	0524	0534	0614	0624	0634	1514	1524	1534
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	21	0	0	10	0	0	22	0	0
40	77	35	0	102	24	0	125	31	0
50	134	79	30	174	95	32	234	102	15
60	189	123	63	231	155	91	335	183	56
70	241	164	97	276	204	143	402	251	110
80	280	197	126	312	245	187	446	319	163
90	315	225	150	341	280	226	477	368	209
100	342	248	169	365	309	259	499	400	253
110	363	265	184	384	334	288	502	423	296
120	376	276	194	401	355	314	507	441	327
130	382	282	200	414	373	336	511	454	352
140	392	290	206	426	389	356	510	464	370
150	401	297	212	436	402	373	511	471	383
160	401	297	212	436	402	373	510	468	394
170	401	297	212	436	402	373	510	467	403
180	401	297	212	436	402	373	510	467	411
190	401	297	212	436	402	373	510	467	415
200	401	297	212	436	402	373	510	467	419
210	401	297	212	436	402	373	510	465	423
220	401	297	212	436	402	373	510	466	424
230	401	297	212	436	402	373	510	462	427
240	401	297	212	436	402	373	510	459	427
250	401	297	212	436	402	373	510	459	423
260	401	297	212	436	402	373	510	456	422
270	401	297	212	436	402	373	510	453	422
280	401	297	212	436	402	373	510	452	419
290	401	297	212	436	402	373	510	451	419
300	401	297	212	436	402	373	510	451	419

Analysis unit legend:
1st and 2nd digit = primary analysis unit (spruce = 1, 7; balsam = 2, 10; pine = 3, 4, 8, 9; aspen = 5, 12 ,55 ,56; balsam poplar = 6, 13, mixed-wood = 15-20);
2nd digit = relative productivity rating (G = 1; M = 2; P = 3);
3rd digit = stand class (thrifty = 1; old = 2; existing and future managed = 4).

(continued)

A.6 Volume Estimates for Regenerated Stands

Table A-27. Projected volumes for regenerating stands (cubic metres/hectare)

Age (years)	Analysis units (regenerating stands)								
	1614	1624	1634	1714	1724	1734	1814	1824	1834
10	0	0	0	0	0	0	0	0	0
20	3	0	0	8	0	0	0	0	0
30	56	14	1	61	13	1	10	0	0
40	137	56	10	151	52	14	63	20	0
50	205	109	34	238	113	40	126	61	15
60	261	158	65	307	171	82	186	108	44
70	305	197	98	368	222	126	243	153	77
80	337	229	127	407	267	164	286	190	107
90	363	257	151	437	309	198	320	224	134
100	387	280	170	456	338	228	347	251	156
110	405	296	187	471	358	253	366	270	176
120	419	309	200	474	374	278	380	284	192
130	428	319	212	475	387	298	387	292	203
140	433	329	222	477	398	313	393	301	212
150	437	336	230	479	406	324	400	308	220
160	440	340	237	479	412	331	400	310	223
170	443	348	243	479	416	338	400	311	226
180	443	350	248	479	420	344	400	312	228
190	443	355	253	479	421	349	400	311	229
200	443	357	257	479	421	351	399	311	231
210	443	357	262	479	42	354	399	311	232
220	443	358	262	479	421	357	398	310	233
230	443	360	263	479	420	358	398	310	233
240	443	361	264	479	417	359	398	310	234
250	443	360	265	479	417	359	398	310	234
260	443	360	265	479	416	360	398	309	234
270	443	363	265	479	413	359	398	309	234
280	443	363	265	479	414	360	398	309	233
290	443	363	266	479	409	358	398	308	233
300	443	363	266	479	409	358	398	308	233

Analysis unit legend:
1st and 2nd digit = primary analysis unit (spruce = 1, 7; balsam = 2, 10; pine = 3, 4, 8, 9; aspen = 5, 12 ,55 ,56; balsam poplar = 6, 13, mixed-wood = 15-20);
2nd digit = relative productivity rating (G = 1; M = 2; P = 3);
3rd digit = stand class (thrifty = 1; old = 2; existing and future managed = 4).

(continued)

A.6 Volume Estimates for Regenerated Stands

Table A-27. Projected volumes for regenerating stands (cubic metres/hectare) (concluded)

Age (years)	Analysis unit (regenerating stands)						
	1924	2014	2024	2034	5514	5524	5534
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	0	11	0	0	21	0	0
40	16	82	7	0	77	32	1
50	84	157	54	0	134	75	33
60	147	224	111	31	189	118	65
70	201	280	163	73	241	158	97
80	248	321	208	113	280	190	123
90	289	353	249	151	315	218	146
100	321	380	283	185	342	240	164
110	348	400	308	215	363	257	178
120	370	413	330	243	376	269	188
130	388	423	347	267	382	274	193
140	403	432	362	289	392	282	199
150	417	440	376	307	401	289	204
160	418	440	377	311	401	289	204
170	420	440	378	313	401	289	204
180	419	439	379	315	401	289	204
190	419	439	379	317	401	289	204
200	419	439	378	319	401	289	204
210	418	439	378	320	401	289	204
220	418	439	378	321	401	289	204
230	418	439	377	322	401	289	204
240	418	439	377	322	401	289	204
250	417	439	377	323	401	289	204
260	417	439	376	323	401	289	204
270	417	439	376	324	401	289	204
280	416	439	376	324	401	289	204
290	415	439	375	323	401	289	204
300	415	439	375	323	401	289	204

Analysis unit legend:
1st and 2nd digit = primary analysis unit (spruce = 1, 7; balsam = 2, 10; pine = 3, 4, 8, 9; aspen = 5, 12, 55, 56; balsam poplar = 6, 13, mixed-wood = 15-20);
2nd digit = relative productivity rating (G = 1; M = 2; P = 3);
3rd digit = stand class (thrifty = 1; old = 2; existing and future managed = 4).

Appendix B

Socio-Economic Analysis Background Information

B.1 Limitations of Economic Analysis

The socio-economic analysis identifies employment and income impacts, changes in government revenues and community impacts at various harvest levels and times in the future. Some of the assumptions used in the analysis are as follows:

- **Employment multipliers** — these multipliers are used to estimate indirect and induced employment impacts of a change in direct industry activity. Employment multipliers are calculated based on analytical assumptions and data collected at a specific time. Consequently, the multipliers reflect industry and employment conditions at that time and may not accurately reflect future industry conditions. While generally good indicators when based on fairly recent information, older multipliers can be dated and may not reflect industry conditions at the time of analysis. In any impact analysis, the information should be considered as indicators of magnitude.
- **Employment coefficients** — employment impacts associated with future harvest levels are calculated using employment coefficients (person-years per 1000 cubic metres). This approach assumes that the industry structure will be the same in future as it is today. While reasonably accurate in the short term, employment coefficients may change in future as a result of changing market conditions or production technologies, for example.
- **Timing of impacts** — employment impacts are shown to occur simultaneously with a change in the harvest level. While fairly accurate for the harvesting sub-sector, this may not be the case for the processing and silviculture sub-sectors of the forest industry. Also, indirect and induced impacts will likely occur over a longer period, as business and consumer spending levels adjust to changes in harvest levels.
- **Processing thresholds** — processing job impacts are unlikely to occur in direct proportion to harvest changes (i.e., a 10% harvest reduction may not lead to a 10% processing employment reduction). Impacts are more likely to occur stepwise related to processing thresholds. A processing threshold is the level of a mill's timber supply where, when reached, will cause a mill to either lay off a shift or shut down the mill, temporarily or permanently. Accurately predicting a mill's threshold level is impossible. As a result, the analysis may overestimate processing impacts if mills continue to operate the same number of shifts, but perhaps at lower production levels, or alternatively could underestimate impacts if a mill were to eliminate a shift. However, over the medium- to long-term the impact figures should be reasonably accurate.
- **Government expenditures** — provincial government expenditures are more related to population levels than to industry activity. As such, expenditures on education, health care and other government services are assumed to remain unchanged despite harvest changes and any subsequent change in government revenues. However, public expenditures would likely change if community population levels change sufficiently. This would amplify the community impacts of forestry job losses or gains.
- **Proportional harvest reductions** — harvest reductions are assumed to be spread proportionately among all licensees and all forms of tenure.

B.2 Economic Impact Analysis Methodology

Data sources

Data for the socio-economic analysis were obtained from several sources. Harvest volume and stumpage data are from the Ministry of Forests. Timber flow and employment data are from responses to questionnaires that were sent to licensees, operators and processing facilities in the TSA. Other general economic data are from BC STATS, the Ministry of Finance, Statistics Canada and local communities.

Person-year of employment

The unit of measurement for employment is a person-year. A person-year of employment is defined as a full-time job, which lasts at least 180 days per year. Part-time jobs were converted to equivalent full-time person-years of employment.

To estimate employment and income impacts associated with changes in TSA timber harvest levels, the forestry sector was divided into three sub-sectors:

1. harvesting;
2. silviculture; and
3. timber processing.

Estimating employment and income impacts involves several steps. First, the current activity in each of the three sub-sectors was assessed. Then, indirect and induced employment and employment income impacts were estimated, using data from the Ministry of Finance, and Statistics Canada. Next, employment coefficients were calculated and applied to the base case harvest forecast. Other indicators of the forestry sector's contribution to the provincial economy, such as government revenues and industry taxes, were also calculated, using Ministry of Forests stumpage estimates and other data sources.

Employment — harvesting

Direct employment in harvesting consists of all woodlands-related jobs including harvesting, log transport, log salvage, planning and administration functions. The employment multipliers used in this analysis define road building and maintenance work as indirect rather than direct employment. Including this employment in direct estimates would result in double counting.

Data on employment, place of residence and timber flows were obtained through a survey of licensees and operators in the TSA. The information was then used to estimate employment averages associated with harvest changes and the proportion of resident *versus* non-residents who work in the TSA.

Two estimates of direct employment in harvesting were calculated:

1. TSA direct employment in harvesting consists of employees who are engaged in harvesting and related activities within the TSA and who reside in communities within the TSA; and
2. Provincial direct employment in harvesting consists of employees who are engaged in harvesting, as above, plus those workers who reside outside the TSA, but who come to the TSA to work in harvesting and harvesting-related activities.

The estimates of TSA and provincial direct employment in harvesting were used to calculate employment coefficients per 1000 cubic metres. These employment coefficients were then used to estimate harvesting employment associated with the different harvest levels in the base case forecast.

Employment — silviculture

Silviculture employment consists of all basic and intensive reforestation activities, including surveys, site preparation, planting, fertilization, pruning and spacing. Silviculture employment data were collected from the Ministry of Forests and licensees whose tenures require post-harvest silviculture work. Most silviculture work is seasonal and silviculture employees usually only work part-time during the year. Because of this, silviculture jobs were converted into equivalent full-time person-years of employment. Respondents were also asked to estimate the percentage of their silviculture employees who resided within the TSA and outside the TSA.

B.2 Economic Impact Analysis Methodology

As with the harvesting sub-sector, two estimates of direct employment in silviculture were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for silviculture employment in the same manner as the employment coefficients for harvest employment.

Employment — timber processing

Information about employment, production and sources of timber was gathered from TSA mills. Information was also gathered as to whether timber harvested from the TSA was processed within the TSA or outside the TSA. This information indicates the degree of dependence the mills have on timber harvested within the TSA. To estimate the share of processing employment supported by TSA timber, mill employment was prorated by the relative contribution of timber from the TSA to a mill's total timber requirement. For example, if 80% of a plant's timber requirement was supplied by the harvest from the TSA, then 80% of the employment in the plant would be attributable to the TSA harvest.

Employment figures were also adjusted to reflect the residences of workers: those who lived within the TSA and those who lived outside the TSA. Employment in timber processing which is supported by chip by-products from milling operations was also estimated similarly.

As with the harvesting sub-sector, two estimates of direct employment in timber processing were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for timber processing employment in the same manner as the employment coefficients for harvest employment.

Indirect and induced employment estimates

Indirect employees associated with the forestry sector are those who supply goods and services to firms directly engaged in the basic forestry sector; for example, those who provide road maintenance services, fuel and office equipment and products. Induced employment consist of those who supply goods and services purchased by employees who are directly and indirectly engaged in the industry; for example, those who work in retail outlets. Indirect and induced employment figures were calculated using TSA and provincial employment multipliers developed by the Ministry of Finance.

Two sets of employment multipliers were used for this report: migration multipliers and no-migration multipliers. The migration multipliers assume that displaced workers will leave the region, reducing total income in the region by their full wage. The no-migration multipliers assume that a displaced worker remains in the area, at least in the short term, and unemployment and other social safety net payments temporarily offset some of the income loss. Using the no-migration multipliers diminishes the induced impacts associated with a change in direct employment.

The TSA and provincial employment multipliers used in the Dawson Creek TSA analysis are shown in Table B-1.

Table B-1. Total employment multipliers

Forest sub-sector	TSA migration multiplier	TSA no-migration multiplier	Provincial interior migration multiplier	Provincial interior no-migration multiplier
Harvesting	1.48	1.33	2.14	1.80
Solid wood processing	1.53	1.34	2.29	1.93
Pulp	1.94	1.69	3.02	2.48

Sources: Horne, G., R. Riley, L. Ransom, and S. Kosempel. 1996. A provincial impact estimation procedure for the British Columbia forest sector.

Ministry of Finance and Corporate Relations. 1999. The 1996 forest district tables.

B.2 Economic Impact Analysis Methodology

Employment estimates of alternative timber supply levels

To estimate employment generated by alternative timber supplies, the forecast harvest level is multiplied by the calculated employment coefficients. Note that employment coefficients are based on current industry productivity, harvest practices and forest management assumptions and will not likely reflect industry operating conditions in the future. Therefore, the employment estimates should be viewed as indicators of the magnitude of change rather than as precise estimates of changes in employment levels.

Estimates of employment income

Employment income was calculated using average income estimates for workers in the forest industry. Income data are from Statistics Canada annual estimates of employment, earnings and hours. From 1998 to 2000, the average pre-tax annual income (less benefits) for sub-sectors of the forestry sector associated with the Dawson Creek TSA was about $47,100 for logging and forestry services; $44,900 for solid wood manufacturing; and $56,400 for the pulp and paper sector. The weighted average annual income for direct forestry workers in the Dawson Creek TSA was $47,138. The average annual income for indirect and induced employees averaged about $30,800. This figure is based on data for all service producing industries from the Statistics Canada Labour Force Survey, B.C. Industrial Comparison, average weekly wage rates. Income taxes were calculated based on marginal tax rates of 22-27% with one-third of the total income tax accruing to the province.

Provincial government revenues

Except for stumpage, royalty and rents, which are specific to the TSA, provincial government revenue impacts were estimated by using industry averages. Revenues per 1000 cubic metres of harvest, expressed as dollars per 1000 cubic metres, were calculated and applied to the harvest levels in the base case forecast in a manner similar to how employment impacts were estimated. Table B-2. summarizes provincial government revenue estimates.

Table B-2. Estimates of provincial government revenue, Dawson Creek TSA

	Average annual revenue 1998-2000 ($1999 millions)	Rate used
Stumpage, rents and royalties[a]	17.6	16.32 / m^3
Industry taxes[b]	9.2	9 050 / '000s m^3
(Total income tax)	(15.2)	26% blended rate
Provincial income tax[c]	5.0	One-third provincial
Total provincial government revenues	31.8	

(a) Ministry of Forests.

(b) PricewaterhouseCoopers.

(c) Based on marginal tax rates from Revenue Canada.